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AN INVESTIGATION INTO THE SALES-ADVERTISING RELATIONSHIP: THE STATE LOTTERY CASE

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AN INVESTIGATION INTO THE SALES-ADVERTISING RELATIONSHIP:

THE STATE LOTTERY CASE

by

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Dedication

To HIM, who showed me the way and walked along with me during trying times.

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An Investigation into the Sales-Advertising Relationship:

The State Lottery Case

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The present investigation aims at modeling the sales response to advertising and, in the process, sheds some light on the sales-advertising relationship subject, which has been at the center of a decades-long controversy due to its inherent complexities. We studied three Colorado Lottery games, Lotto, Powerball, and Scratch, over a four-year period of operation. To synthesize a model that appropriately described the sales-advertising behavior of each one of these games, we addressed three fundamental questions driving the modeling process itself: 1. Is there a relationship between sales and advertising? 2. If such relationship exists, is there an advertising "carryover effect" on sales? And, 3. What is the shape of the sales-advertising relationship?

We put forward two general-response models (Current Effects and Koyck's) in combination with eight functional forms (one linear and seven nonlinear forms) to address the above questions and test the respective hypotheses. Employing the available

time series data corresponding to game sales, game advertising expenditures, state population, state unemployment rate, and jackpot (for the relevant games), we performed the respective regression analyses. We, then, evaluated the posited relationships and selected the best predictive model for each game, when statistical evidence supported a significant sales-advertising association. Using this final model, we addressed the three research questions at the core of this study.

The results of this investigation suggested the existence of a significant positive and nonlinear (concave-downwards) Scratch sales-advertising relationship. No sales-advertising association was found for the Lotto or Powerball games. The data analyzed did not seem to support either the advertising "carryover effect" on sales on any of the games studied. From the theoretical point of view, these findings extend prior empirical research that has generally assumed, for simplification purposes, a linear sales-advertising relationship with its corresponding consequences. From the practical perspective, this study highlights advertising's contribution to sales, which can help debunk mistaken beliefs frequently stigmatizing advertising as a resource-spending function and quell the long-established skepticism about its financial accountability.

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Chapter 1: Introduction

Advertising is one of the most important and perplexing promotional tools marketing management has available. Advertising's complexity stems from the nonlinear nature of its effects, its interaction with other variables in generating sales, and the fact that its effects can play out over time.

The shape of sales response patterns and the dynamics that characterize the sales-advertising relationship have been the subject of discussion and controversy in research circles for many years. Today's growing emphasis on advertising accountability reminds us about and underscores the importance of advertising sales response modeling since it can enable management to forecast sales, estimate optimal advertising levels and, thus, reduce operational inefficiency. The present empirical investigation constitutes a step in that direction and, in the process, it aims at shedding some light on the sales-advertising relationship subject.

For this research, we chose to study four years of operation (FY 2001-2004) of the Colorado Lottery. We decided to investigate lottery data since state lotteries operate in the absence of competitors in the same state, which eliminates competitive effects from the analysis.

This dissertation begins with an overview of the Colorado Lottery (Chapter 2) that focuses on its historical background, some of the marketing challenges it has faced in recent years, its game portfolio, and the Colorado Lottery player profile.

Chapter 3 carries out a literature review explaining, first, how advertising works and what factors may influence lottery product purchases. We, then, discuss the sales-advertising relationship subject, its controversial issues, and the theoretical concepts and particular mathematical models that could help us better understand and address those issues.

In Chapter 4, we present the specific research questions and corresponding hypotheses that drive our investigation and discuss the dataset, variables, and quantitative methodology we use to address them. Here we put forward the general sales-response models we use to address the research questions corresponding to each of the lottery games. The models in reference show how the sales response measure relates to advertising expenditures and the demographic and economic variables selected for this investigation.

In Chapter 5, we undertake the modeling process itself by specifying each particular model; advertising and marketing theories provided the necessary groundwork for this initial stage. We consider several possible nonlinear model specification alternatives. Next, we estimate the parameters and corresponding statistics for each model alternative using the available data, evaluate their adequacy, and select the best models for each of the games, in the cases where there is statistical evidence of a significant sales-advertising relationship. Finally, using a holdout sample obtained in advance from the original dataset, we perform an acid test on the selected models and choose the one that yield the best forecasting results for each game.

This investigation closes with the corresponding conclusions and recommendations which are detailed in Chapter 6. The results of this study suggest the existence of a statistically significant nonlinear sales-advertising association, in the case of Scratch games. On the other hand, the analysis upshot does not provide significant statistical evidence supporting a sales-advertising relationship for the Lotto or Powerball games. These differing outcomes seem to indicate that sales-advertising behavior varies from game to game and, thus, it should not be generalized.

Chapter 2: The Colorado Lottery: Background

To place this investigation in perspective, Chapter 2 presents a historical outline of the lottery from the global, U.S., and state standpoint which includes an overview of some of the marketing issues faced by the Colorado Lottery during the 2001-2005 period. This chapter, then, discusses the Colorado Lottery game portfolio and closes with the profile of its lottery player.

2.1 History of the Lottery

2.1.1 Global History

The origins of the lottery can be traced back to the Pharaohs of Egypt and Moses. The Book of Numbers of the Old Testament states that Moses was awarded a tract of land west of the River Jordan through a lottery (Winning with Numbers 2006). Also, archeological evidence has been found of the existence of lottery games in the Han Dynasty from 205 and 187 B.C. (World Casino Directory 2007). Historians assert that the funds obtained from these lotteries were used to build the Great Wall of China and that several forms of that game also existed during Julius Cesar's time (OSA Lotteries 2007).

Between the 15th and 17th centuries, lotteries rapidly spread throughout Europe. Countries established lotteries during those years to replenish their depleted monetary resources and, thus, meet their fiscal and social needs. In 1420, various French towns used the lottery as a means to fund the buildup of their defense. Also, looking for a way to raise money to assist the poor and needy, Belgium and Portugal established lotteries in 1466 and 1498, respectively (Awwad 2007). By 1530, the lottery fever reached Italy when they established the lottery in Florence. "Il Lotto di Firenze" was the first municipal lottery and also the first one to offer prize money (Lottery Syndicate World 2007); it is germane to note here that some believe that the word "lottery" comes from the Italian word "Lotto" which means "fate" (Awwad 2007).

In 1520, the French King Francis I officially allowed the first ever state lottery operations in his country. News of the French Lottery financial success prompted Queen Elizabeth I to establish the first English lottery in 1567; interestingly, the 400,000 tickets offered for sale sold out (World Casino Directory 2007). Later, in 1727 and 1783, respectively, the Netherlands and Queen D. Maria Pia of Portugal instituted their corresponding state lotteries, which are two of the oldest in the world still running today (OSA Lotteries 2007).

2.1.2 The Lottery in the U.S.

The history of the lotteries in the USA followed a more convoluted course. It began with the financing of the settlement of Jamestown, Virginia, in 1612, by means of a lottery (About 2007). In the 1700's, the lottery became the favorite pastime of many, including the founding fathers. It is known that Benjamin Franklin paid for the cannons for the Revolutionary war, and George Washington financed the construction of roads to the West from Virginia with lottery money (EzineArticles.com 2007).

After the adoption of the Constitution, lotteries thrived in the United States and were used to fund over 300 schools and 200 churches. Ivy League schools such as Harvard, Columbia, Princeton, and Yale were founded with lotteries. During this period, lotteries became widespread in this country. Things, however, started to change in 1820 because of the rampant corruption plaguing privately operated lotteries due to lack of regulation. As a consequence of such irregularities, in 1820, the State of New York banned lotteries.

By 1878 all states, except Louisiana, had prohibited lotteries. In 1905, however, The U.S. Supreme Court banned all gambling in all states, including Louisiana, thus, ending its century old lottery operation. It was not until 1964 that the United States would see a lottery again (winingwithnumbers.com 2007). In December 1964, New Hampshire created the first state lottery. New York followed suit in 1967, and after that, many other US states established their own state lottery (Lottery Syndicate World 2007).

In 1974, the first instant scratch-off lottery ticket, "The Instant Game," was introduced by the Massachusetts State Lottery. This game was highly successful since it offered players the possibility to win instant money, something not offered by any other lottery game until then. By 1976, 13 other states had launched instant lottery games. By the 1980s, 16 states were selling instant games with total revenues exceeding $1 billion dollars. In the meantime, U.S. lotteries in the Northeast were using some innovative strategies to increase instant sales, which involved multiple game-marketing, new prize structures, and less jackpot drawings for the top prize. Massachusetts duplicated its instant sales to $80 million dollars using such approach. These strategies worked basically because they encouraged players to reinvest their small winnings in buying more tickets. The Massachusetts Lottery experienced further success by implementing the direct distribution of tickets to retailers, which tripled its sales in 1985. The success of instant games prompted the launching of many other state lotteries around the U.S. (OSA Lotteries 2007).

As of 2008, lotteries were established in 42 states, the District of Columbia, and the Virgin Islands. According to The Heartland Institute (2005), in the fiscal year 2003, total lottery sales in the U.S. were approximately $45 billion and advertising expenditures reached the half billion level. State lotteries contributed, on the average, approximately thirty percent of their income to their respective states, thus, becoming an important source of funding for education, environmental preservation, elderly care, and economic development (Heartland Institute 2005)

2.1.3 The Colorado Lottery (1982-2005 Period)

On July 1, 1982, the State of Colorado General Assembly passed Senate Bill 119 creating a state-supervised lottery. This bill instituted the Colorado Lottery as a division of the Colorado Department of Revenue. The Colorado Lottery was charged with the generation of revenues through the sale of its products, and its mission has been, since, the maximization of its income to fund its proceed recipients. The Colorado Lottery allots its earnings, after expenses and prizes, to the Conservation Trust Fund for state parks, outdoor recreation programs, and state Capital Construction projects with a distribution formula of 40, 10, and 50 percent, respectively.

The Colorado Lottery officially began operations on January 24, 1983, when it sold its first Scratch ticket. The first week Lottery sales exceeded all expectations, having reached $137 million when only $60 million had been projected.

Six years later, on January 24, 1989, the Lottery launched its Lotto game in a five-city celebration; first week total sales (five days) reached $913,390. To maintain Lotto sales growth, the Lottery introduced a second weekly Lotto drawing on July 18, 1990, with drawings held every Wednesday and Saturday. Later, on July 10, 1994, the Lottery launched the Cash Value Option, which offered Lotto players the choice of taking their jackpot prize in a 25-year progressive annuity or in a lump sum equal to 40 percent of the estimated annuitized jackpot.

On September 16, 1996, the Colorado Lottery launched Cash 5. This was the Lottery's first new on-line game introduced since 1991. Keeping pace with technological advancements, in September 1998, the Colorado Lottery set up Player Express Terminals at its vendors' sites, the first of their kind in the industry in this country. These terminals offered consumers the convenience of one-stop shopping since they were placed at checkout lanes in multi-register retailers.

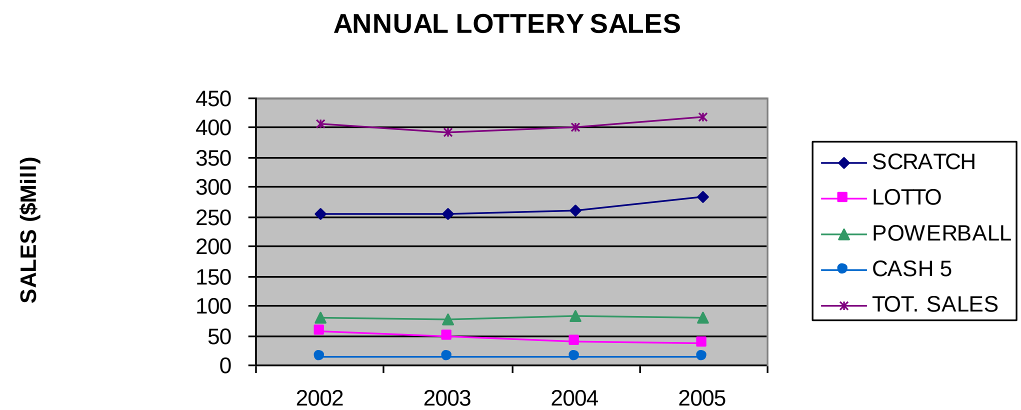
In 1999, the Colorado Lottery was directed by state government to essentially stop trying so hard to sell tickets with advertising. The Colorado Lottery was not allowed to mention the amount of the Lotto jackpot or the amount of top prize for scratch games.

The organization was not allowed to "appeal to gamblers' instincts, create unrealistic expectations about winning" or talk about what winners might dream of how they would use the money. The Colorado Lottery could not show people winning or even the anticipation of winning. They could not offer any kind of promotional deal such as "buy 5 get one free" or use coupons to sample a free product to encourage trial. So, in 1999, The Colorado Lottery advertising essentially became a matter of just telling consumers that the lottery profits went to parks, recreation, wildlife and outdoor open space. In other words, advertising was limited to a "feel good" message. It was not until FY 2005 when the Colorado Lottery regained the ability to mention jackpot amounts or scratch top prize amounts (Colorado Lottery 2008).

On November 7, 2000, through a referendum, Colorado voters allowed the Lottery to participate in multi-state lottery games. The Lottery launched the mega-jackpot game Powerball on August 2, 2001. Over 2,500 retailers participated in the introduction of this new product form.

In February of 2002, the Lottery added two more drawings to Cash 5, bringing the total number of drawings to six nights a week. These additional drawings helped push Cash 5 sales to $13.2 million for FY 2001 up from $12.5 million the year before (see Figure 2.1). In FY 2001, the Lottery and General Motors teamed up for the "Scratch game Chevy Road Trip." The Lottery supported the game with statewide promotions during the summer. At the end of the 2001 fiscal year, the Colorado Lottery set an all-time record in Scratch sales of over $249 million. The previous record was $234 million set in fiscal year 1999 (The Colorado Lottery 2007).

Figure 2.1: Annual Lottery Sales.



	6/30/02	6/30/03	6/30/04	6/30/05
SCRATCH	256.52	254.25	260.85	282.81
LOTTO	57.79	48.42	40.70	38.47
POWERBALL	79.67	76.28	84.47	80.98
CASH 5	13.22	13.25	14.50	15.08
TOT. SALES	407.2	392.2	400.5	417.3

The Fiscal Year 2002 was a disappointing one since Colorado Lottery sales decreased with respect to those of 2001 for the Scratch, Powerball and Lotto games; Cash 5 sales level remained approximately the same (see Figure 2.1). Such disappointing results reminded the Colorado Lottery that some of its games had reached maturity and that management needed to devise and implement an innovative marketing strategy to reverse the declining sales trend to secure the profitability of its operations and, thus, ensure its future viability.

Using the experience they had accrued over the years in the lottery business and their knowledge of the industry, they developed and deployed a marketing strategy that included, among other things, the following tactics (Colorado Lottery 2007):

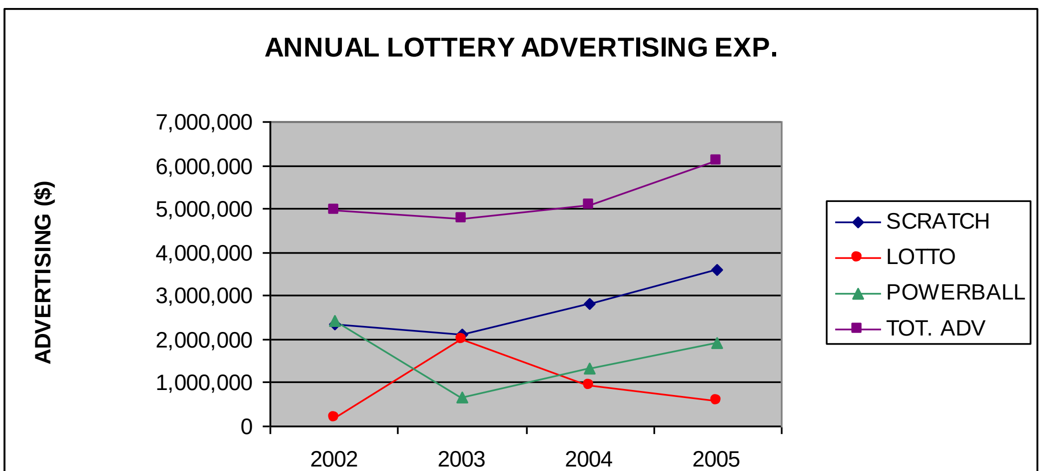
- Actively support the games and, particularly, Scratch games with creative advertising campaigns since Scratch constituted the bulk of the Lottery's revenue. The Colorado Lottery rolled out these campaigns periodically, focusing on Scratch families of games; tickets at different price points focused on specific themes. The rationale behind this was the belief that lottery advertising not only expanded the lottery player base but also stimulated increased product usage.
- Improve the visibility of Scratch games in supermarkets since research had detected a deficiency in that area. Additionally, focus event marketing efforts on Scratch tickets.
- Change existing games to refresh them and continually introduce new and innovative ones to retain regular players and attract a new player base. Lotto had not changed since 1989 when it was introduced, and Cash 5 hadn't significantly changed either since its inception. These games required additional advertising or marketing efforts, a game feature addition or other changes in order to stay relevant in a world that demanded new and exciting products.
- Design imaginative promotions. An example of the Colorado Lottery implementation of this tactic was the August, 2004 introduction of its first ever second-chance Internet promotion; this promotion allowed players who purchased a $2 Scratch ticket to enter their non-winning tickets into a drawing through the Lottery's Web site.

- Sell game-related promotional merchandise through a web site as an alternative source of income.

- Place new features on the Colorado Lottery website to better assist players and also increase media coverage. It is worth noting here that to interact with its customers, aside from its advertising and a network of approximately 2800 retailers, the Colorado Lottery uses its official Website. In 2005, the Lottery Website averaged over 27,543,300 hits per month, which made it one of the most popular Websites in the state.

- Conduct research on a regular basis to determine new ways to provide consumers with more involvement, fun, and participation (Colorado Lottery 2007).

Figure 2.2: Annual Lottery Advertising Expenditures



	6/30/02	6/30/03	6/30/04	6/30/05
SCRATCH	2,347,673	2,096,375	2,803,799	3,600,810
LOTTO	179,071	2,002,098	937,037	595,493
POWERBALL	2,422,429	683,386	1,338,462	1,901,947
TOT. ADV	$4,949,173	$4,781,859	$5,079,297	$6,098,251

As Figure 2.2 shows, following its marketing strategy, the Colorado Lottery increased Scratch and Powerball advertising expenditures by 71 and 178 percent, respectively, between FY 2002 (6/30/03) and FY 2004 (6/30/05). In the same period, Lotto advertising expenditures went down 70 percent, and no money was spent on Cash 5 advertising, a decision justified by the low advertising elasticity characterizing this game. We should mention that during the FY 2001-2004 period, the Colorado Lottery allocated, on the average, eighty percent of its media budget to television and radio advertising and the remaining twenty percent to outdoor and newspaper advertising. It is relevant to note here that the Colorado Lottery Commission establishes the lottery advertising budget based on objectives, and funds allocation followed this policy.

The sales levels achieved in FY 2003 and 2004 (see Figure 2.1) suggested that the marketing strategy implemented by the Colorado Lottery seemed to have contributed to the reversing of the declining trends. Scratch, Cash 5, and Powerball sales revenues increased 11.5, 13.6, and 6.2 percent, respectively, from FY 2002 to FY 2004. Lotto sales, however, continued decreasing, showing a 20.7 percent drop in the same period. Such losses were, nevertheless, offset by the sales increase experienced by the other three games during this time, as shown on Figure 2.1.

Although the Colorado Lottery management was mostly pleased with the results obtained with the implementation of their strategy in the FY 2003 and 2004, they were aware of the fact that in the following years, they needed to focus on crucial and ever-present issues such as attracting and retaining new players, expanding the retailer base as

Colorado grew to remain accessible and convenient to players across the state, and, counteracting the sales erosion resulting from the aging of the Lottery's current products (Colorado Lottery 2007). The Lottery management understood that the attainment of its mission and its ultimate viability as a business organization heavily depended on how successfully it would meet, among others, the above indicated challenges.

2.2 THE COLORADO LOTTERY GAME PORTFOLIO

To successfully advance its revenue-generating mission and, thus, support the Conservation Trust Fund projects and activities, the Colorado Lottery offers 4 different games to entertain players: Scratch, Lotto, Cash 5, and Powerball. Below is a detailed description of each (Colorado Lottery 2007).

2.2.1 Scratch Games

A scratch game is a scratch-off ticket with hidden prizes. It allows players to find out immediately if they have won. Scratch games offer more small prizes than any of the Colorado Lottery's online games, such as Lotto, Cash 5 or Powerball. Instant games are the most popular and successful Colorado Lottery product. Different game themes and prize structures are periodically introduced to sustain player interest.

The diversity in the Colorado Lottery's product line is represented by Scratch games. The Colorado Lottery offers a wide assortment of instant games, which come in many sizes and shapes and offer varying prizes, ranging from $1.00 to $500,000 depending upon the game one chooses to play. Each game is unique - from the Match 3 style games, to extended play games such as Crossword or to the more complex games that offer multiple play options all on one ticket.

2.2.2 Lotto

The Colorado Lottery's in-state jackpot game is the Lotto. In this game, players select six numbers from a field of 42, and prizes are awarded for matching 3, 4, 5 or 6 of the numbers. This game has a "rolling" jackpot, which means that it increases each drawing when the previous jackpot is not won. Lotto Drawings take place every Wednesday and Saturday. The probability of winning a Lotto jackpot is 1 in 5,245,786. Overall probability of winning is 1 in 35. Prizes equal at least 50% of sales overall. Each play costs $1.

2.2.3 Cash 5

This game was introduced in 1996. Cash 5 plays like Lotto, but offers better probability of winning. Players choose five numbers from a field of 32 possible numbers and win cash prizes by matching 2, 3, 4, or 5 numbers. All prizes are paid in one lump-sum payment. Drawings are held Monday through Saturday. The top prize of the game is $20,000. Probability of winning the top prize is 1 in 201,376, and overall probability of winning is 1 in 6.2.

2.2.4 Powerball

Powerball is the Colorado Lottery's multi-state jackpot game. Powerball is played in 29 states, Washington D.C. and the U.S. Virgin Islands. Multi-state games combine a large jackpot game and a cash game. Every Wednesday and Saturday night, five white balls are drawn out of a drum with 55 balls, and one red ball is also drawn out of another drum with 42 red balls. Players win by matching one of nine ways to win. The jackpot (won by matching all five white balls in any order and the red Powerball) is either an annuitized prize paid out over 29 years (30 payments) or a lump sum payment. The second prize (won by matching five white balls in any order) is $200,000 paid in cash. Also, any time a player matches the red Powerball, he/she wins. The overall odds of winning a prize in this game are better than 1 in 37.

Power Play has a special feature (Power Play option) that allows a winner to multiply the original prize amount for an additional $1. Powerball players can multiply their Powerball prizes by 2, 3, 4 or 5 times (does not include the jackpot). A player must choose the additional Power Play option when they buy their Powerball ticket, and then the ticket must match one of the non-jackpot prizes before the multiplier takes effect.

The description of the Colorado Lottery game portfolio leads us to address the question: Who plays these games? The next section deals with this topic.

2.3 WHO PLAYS THE LOTTERY?

A business organization can make better, more consistent customer decisions about how to best market and sell, including which products and services to offer and how to most effectively communicate their features, benefits, and availability when it knows its customers. Clearly understanding one's customers fosters better products and services, better marketing strategies, and better communications. Being aware of the importance of knowing its customer base, the Colorado Lottery has ascertained through independent research that its Lottery players look very much like the typical Coloradan (Colorado Lottery 2007). Such studies have suggested that the average Colorado Lottery player:

- Is in their late-30s to mid-60s
- Is married
- Has a household income of more than $40,000
- Has at least some college education
- Likes to use the Internet for fun and information
- Enjoys going out to restaurants

Additionally, playership tracking studies (coloradolottery.com 2007), which are conducted several times throughout the year to determine how effective the Colorado Lotto advertising is, and how that correlates with playership, have found that:

- 83 percent of the population said they had played a Colorado Lottery game
- 60 percent of the population played a Lottery game within the previous year.

Since, nowadays, a company’s success is frequently tied to social and ethical issues, given the nature of its business, a lottery organization should strive to operate with security and integrity, and effectively communicate that such standards are at the core of its commercial practices. Players must believe the money generated by the Lottery goes to a worthy purpose, and that they benefit from this purpose, if a Lottery organization is to succeed in its money-making endeavors. To assess the Colorado Lottery's image and favorability among players, independent research is conducted at least once per year. A recent study carried out by the Howell Research Group of Denver found that 84 percent of respondents were in favor of the Lottery and that all demographic segments and geographic locations expressed favorability toward the Lottery (Colorado Lottery 2007).

2.4 SUMMARY

In this chapter we outlined the history of the lottery at the global, U.S. and state level. We also provided information regarding the marketing strategy used by the Colorado Lottery to deal with some of the challenges it faced during the FY 2001 - FY 2004 period and described this organization's game portfolio and lottery player profile.

The following chapter, Chapter 3, presents a perspective on how advertising works. It then proceeds to discuss past research on the sales - advertising relationship, its controversial issues, and the relevant theoretical concepts that form the conceptual framework used to address the research questions that occupy this investigation.

Chapter 3: Literature Review and Conceptual Framework

A research endeavor like this one requires a discussion of the fundamental theoretical issues laying at the foundation of the advertising problem under examination. Although the central objective of this research is to model and examine the Sales-Advertising relationship for lottery products without considering intermediate behavioral variables, to place things in context, we deemed it pertinent to, first, present an explanation of how advertising works and describe the factors likely to influence consumers' lottery buying behavior. Understanding how advertising works from the behavioral perspective is important since the final and fundamental objective of any advertising endeavor is to influence consumers' behavior. Next, we present a literature review on the sales-advertising relationship, its controversies and relevant theoretical concepts, since they are at the foundation of this research effort. And, finally, we close this chapter by presenting the general models we plan to use to address the research questions regarding the effects of advertising and the shape of the sales-advertising relationship as they apply to the lottery case.

3.1 An Explanation of How Advertising Works

A number of theories have been proposed over the years to explain how advertising works. Among them, there is a group of three related models that offer a simple and yet lucid explanation of the processes by which advertising is presumed to influence consumers' decision making. These theories of the effect of advertising on behavior share three different communication effects concepts that advertising can attain: thinking, feeling and acting (Ramond 1976). These advertising influence models have been classified into three major categories, each characterized by a specific sequence of the above indicated behavioral components:

1. Thinking - feeling – acting
2. Acting - feeling – thinking
3. Thinking- acting – feeling

The first model of message effects was developed by Michael Ray (1973). This author states that consumers approach a purchase situation using a sequence of responses. This means that consumers first learn about a product, then form an opinion or attitude about it, and, finally, buy it. Lavidge and Steiner's (1961) hierarchy of effects is associated with these behavioral stages. In their seminal article, these authors argue that advertising is a "force" that moves consumers through a seven-stage hierarchy to attain the desired behavior: Unawareness, awareness, knowledge, liking, preference, conviction, and purchase. The basic proposition of this model (and other similar models) is that thinking comes before feeling, and feeling precedes acting. According to Ray (1973), this model appropriately describes the purchasing process of high-involvement products likely to occur when product alternatives are well differentiated, mass media play an important role, and the product is going through the early stages of its life-cycle (ex.: cars, appliances, etc.).

It is relevant to note that although the first model provides a compelling explanation of what advertising "does" to consumers, it does not explain all types of consumer behavior. One example of this deficiency becomes evident if this model is applied to the purchasing situation involving a relatively undifferentiated product. Such a process cannot be explained by the Lavidge and Steiner's model; it can, however, be explicated using the second model, which is characterized by the acting-feeling-thinking hierarchical sequence whose origins can be traced to cognitive dissonance theories. According to this model, consumers try a product and, then, learn from the experience. This is known as a rationalization model because consumers usually choose from several alternatives and then rationalize their decision by developing strong positive feelings about the product (Wells et. al., 1995). As Ray (1973) asserts, this model is used if consumers are involved, there is little product differentiation, personal selling plays an important role, and the product is in the early stages of its life-cycle (ex.: soft drinks, candy, long-distance calls, etc.).

The last model involves the thinking-acting-feeling hierarchy of effects. Krugman (1965) proposed this model. This author suggests that the way in which consumers respond to and process advertising information is influenced by the level of the consumer's involvement with the media and the product. According to Krugman, television, in particular, allows consumers very limited control over the timing and speed of the messages they receive. In his opinion, this lack of control may lead them to lower-level learning such as basic information storage; consumers, then, later might retrieve this information and use it in a buying decision (Farris & Quelch, 1983). This model suggests that consumers learn about a product, try it, and then form an opinion about it. The thinking-acting-feeling model suitably describes purchasing situations characterized by low consumer involvement or when there is minimal difference between products requiring little decision making, broadcast media are important, and the product is going through the later stages of its life cycle. Impulse buying falls into this purchasing behavior category (Wells et. al., 1995). Since lottery product purchases are considered an impulse buy, a succinct discussion of such buying behavior and the factors that may influence it is apposite here.

3.2 A LOOK INTO IMPULSE BUYING

Impulse buying is defined as the sudden, frequently powerful and persistent desire experienced by a consumer to buy something immediately (Rook 1987). According to Dholakia (2000), Rook (1987), and LaRose (2001), today's widespread availability of credit cards, ATMs, and the pervasiveness of convenience stores and the Internet provide the ideal environment for impulse buying consumption. Cobb and Hoyer (1986) affirm that 90 percent of all consumers make impulse buying purchases although only 40 percent categorize themselves as impulse buyers (Rook and Fisher 1995). Since impulse buying requires a very low degree of personal involvement, consumers are often unaware of it; additionally, consumers are reluctant to admit they are impulse buyers because it has been generally perceived as a sign of psychological immaturity or lack of behavioral control (Hausman 2000). Although these issues have made it difficult for researchers to accurately quantify impulse buying, its impact on sales in the marketplace is substantial (Bellenger & Korganokar 1980).

3.2.1 Factors Influencing Impulse Buying

Three broad groups of factors have been identified as influencing impulse buying: product characteristics, consumers' characteristics, and situational/socioeconomic factors. These factors are briefly discussed next (Kwon 2002).

3.2.1.1 Product Characteristics

According to Bellenger, Robertson, and Hirshman (1978) consumers tend to impulse buy some specific products more than others. These authors investigated several product lines such as cosmetics, snacks, meals, stationary, etc. to identify the product lines most likely to be purchased impulsively. On the other hand, Stern (1962) researched the product characteristics that influence impulse buying and found that low price, marginal need for an item, mass distribution, self-service, mass advertising, prominent store display, short product life, small size or light weight, and ease of storage were salient characteristics of product lines more likely to be purchased impulsively. If we evaluate the lottery product line on each of Stern's criteria, it is safe to conclude that lottery products fall into the impulse purchase category since lottery tickets are cheap, small and almost weightless, easy to store, mass advertised, have prominent store display, and have a short product life. Hence, given their characteristics, we can conclude that lottery products are likely to be bought on impulse.

3.2.1.2 Consumer Characteristics

One of the most frequently consumer characteristics mentioned in the literature is consumer's impulse buying tendency (Rook, 1987). According to Bellenger et al. (1978), the influence of personal characteristics on impulse buying may vary depending on the product line; in other words, these authors suggest that there seems to exist an interaction between consumer and product characteristics.

Beatty and Farrell (1998) assert that in addition to consumers' buying tendency, consumers' level of shopping enjoyment and consumers' product and brand identification may also influence consumers' buying behavior. In these authors' opinion, some consumers enjoy shopping more than others; such positive shopping affinity makes people who enjoy shopping more likely to have increased intentions and opportunities to get involved in impulse purchases.

Bellenger's and Beatty and Farrell's consumer traits findings lead us to conclude that consumers with a higher impulse buying tendency and those who enjoy shopping are more likely to get involved in the impulse purchase of lottery products.

3.2.1.3 Situational Factors

Recent research has suggested that, in addition to product characteristics and consumer characteristics, situational factors also have an influence on impulse buying. Dholakia (2000) and Beatty and Farrell (1998) indicate that financial availability and time availability constitute situational factors that affect impulse purchase behavior. Beatty and Farrell (1998) indicate that financial availability determines consumers' affective state and actual impulse enactment. In the case of lottery products, financial availability is assumed since the price of lottery tickets is low. Thus, following Betty and Farrell's rationale, low ticket price brings about the affective state that leads players to their impulse purchase of lottery tickets.

According to Dholakia (2000), marketing stimuli such as point of purchase advertising, prominent display, discounted price, and package can be categorized as situational factors also, since they constitute marketplace situational changes. This author affirms that such marketing stimuli, along with product- and consumer-related factors, may influence consumers' impulse buying.

Dholakia's conclusions find a strong support in many of the time-tested promotion tactics implemented by lottery organizations at their retailers' sites to motivate sales. Consumers shopping at convenience, grocery, or liquor stores (where lottery tickets are mostly sold) are exposed to several of the above marketing stimuli. In these business establishments, any consumer standing in line would find it difficult to miss the strategically and prominently placed lottery point-of-sale advertising and the lottery ticket machine by the checkout register. The objective of such visual cues is unambiguous: to trigger consumers' lottery impulse buying behavior.

Our review of how advertising works and impulse buying takes us to the discussion of the sales-advertising relationship, which is at the core of the present research.

3.3 THE SALES-ADVERTISING RELATIONSHIP

The relationship between advertising and sales has been empirically studied since the 1930s. Scholars' interest in what now has come to be known as sales response analysis (Vakratsas and Amber 1999) has been motivated by a decades-old marketing managers' need to effectively assess the efficacy of their advertising endeavors.

The earliest sales-advertising relationship studies involved simple linear regression models and static demand functions. Later studies progressed to multiple regressions and dynamic demand functions. Recent research has branched into causality tests based on time series analysis. The common objective of all these research efforts has invariably been to specify accurate models of the advertising-sales relationship without accounting for details of the hierarchy of psychological states transitions. In other words, in these studies, the process by which stimuli relate to intervening variables, and the process by which intervening and, frequently, unobservable variables relate to behavior are not made explicit but are treated as a "black box."

A considerable number of econometric studies of advertising effectiveness for consumer products have been carried out in the last five decades. In one way or another, researchers have addressed, through their investigative efforts, one or more of the following three fundamental and related questions:

1. Is there a relationship between sales and advertising?

If such relationship exists,

2. Does advertising have current and/or "carry over" effects on sales?

and,

3. What is the shape of the curve that characterizes the sales-advertising relationship?

We will examine each one of these issues next.

3.3.1 Is There a Relationship between Sales and Advertising?

Seminal research by Bass and Parsons (1969), Clarke, (1976), Kyle (1978), Weinberg and Weiss (1982), Weiss and Windal (1980), and Deighton et al. (1994), among others, have examined the sales-advertising relationship at the micro level. On the other hand, Little (1979), Hanssens (1980), and Wilkie and Moore (1999), to mention a few, have studied the sales-advertising relationship from the macro point of view (at the aggregate level). The results of the analyses carried out by researchers from these two camps have often offered contradictory answers (between, and even within camps) regarding the sales effectiveness of advertising, with some studies suggesting that advertising is very effective while others stating it is a waste of money.

Additional evidence confirming the indicated results discrepancy has been presented by, among others, Tellis (1988), who found no significant relationship between advertising and sales, and Assmus et al. (1984) whose study concludes that the effects of advertising on sales are small but significant. Moreover, Lodish et al. (1995) argued in their study that increased advertising weight increased the sales of only 33 percent of the established brands they studied, while it augmented the sales of 55 percent of the investigated new brands; the implication of these results is that advertising expenditures seem to have a greater effect on sales of new brands as compared to sales of established brands. Aaker et al (1982) found no significant sales-advertising relationship for six cereal brands using 200 monthly observations for several of the brands. Sexton (1970) estimated the primary demand and brand share of a frequently purchased grocery product using weekly panel data and found that in neither model the current week's advertising had a significant effect on sales for the same period. Bass and Clarke (1972) used monthly data to estimate a distributed lag model for a dietary product; the coefficient estimate of the linear, current period advertising variable was small but significant, implying that the advertising effort only had an effect on current sales; such effect did not extend beyond the current period. Aaker and Day (1974) tested a model with bimonthly data on five brands of instant coffee. Using market share as the dependent variable, they found that the advertising effect on market share was not significant in any of the coffee brands they investigated. It is germane to note here that to control for other sales drivers, many of the above-indicated studies have used, in addition to advertising, other marketing, demographic, and socio-economic variables. This matter will be discussed in more detail ahead in this investigation.

On the specific subject of Lottery-Sales-Response-to-Advertising occupying the present investigation, there exists very limited research. Investigations by Akay (2007), Garrett and Sobel (2002), DeBoer (2001), Mikesell (1987), Heavy (1978), and Vrooman (1976) have examined the relationship between lottery sales and socioeconomic, demographic, and trend variables. These authors, however, did not include in their analyses advertising expenditures as an additional independent variable to explain lottery sales.

The few existing studies on the lottery sales-response-to-advertising have yielded inconsistent outcomes. This is confirmed by Mizerski et al. (2001), who suggests that there is not sufficient evidence supporting the influence of lottery advertising on sales. Results obtained by Heiens (1993), Stone (2000), Zhang (2004), and Borg and Stranahan (2005) attest to this statement.

Heiens (1993) studied the influence of newspaper, radio, and television publicity on Lotto sales. Heiens analyses included radio advertising, television advertising, distribution, and jackpot size as additional independent variables. This investigation included several time series regression equations to test this study's hypotheses. Since this investigation recognized the potential cumulative or carry-over effect of the independent variables, each regression equation was calculated via the Koyck specification to test the existence of the indicated carry-over effect on Lotto sales. The results of this investigation suggested, among other things, that no statistically significant relationship existed between television or radio advertising and lottery sales. Borg and Stranahan (2005) arrived at a similar conclusion; their research found no evidence to support the contention that advertising is responsible for high rates of lottery participation and expenditures by lower income groups.

On the other hand, Stone's (2000) investigation on the determinants of Texas' lottery revenue and Zhang's (2004) economic analysis of state lotteries offer statistically significant evidence of the impact of advertising expenditures on lottery sales. In his investigation, Stone (2000) proposed a model explaining lottery revenues as a function of lottery payout rate, advertising expenditures, number of large jackpots, and unemployment rate. The corresponding regression analysis suggested a significant association between advertising expenditures and unemployment rate with lottery revenues. Stone's investigation indicated that for every additional dollar spent on advertising, lottery revenue increased by $47.37. Zhang (2004), on his part, carried out quasi-experiments in three state lotteries (Illinois, Washington, and Massachusetts) where advertising budgets of state lotteries were exogenously cut by the state legislature. The results of this study suggested that a decrease in advertising expenditures by a state government is linked with a loss of net revenue at the margin. Zhang's findings indicated that state lotteries may advertise too little in terms of maximizing profits, which contradicts the idea that state lotteries spend excessively on advertising. This author's analysis yielded estimates of advertising elasticity ranging from 0.07 to 0.16.

Dertouzos (2003) points to methodological inadequacies as a possible reason for the incongruity in results in sales-advertising relationship studies. According to this author, some of these weaknesses are inherent in the restrictive assumptions of the econometric models used. Examples of such deficiencies are failing to allow for advertising carryover effects, since there is evidence suggesting that when an advertising campaign is over its effects do not end; they may continue in an attenuated fashion for some time (Lillien et al. 2003). Other weaknesses include the failure to control for sales drivers other than advertising (variable omission), and restricting the shape of the sales-advertising relationship in questionable ways. This last weakness is found very frequently in the literature where, for simplification purposes and as approximation, the linear functional form is commonly used to model the sales response to advertising when it is widely accepted that the sales-advertising relationship is nonlinear in nature. The historical lack of agreement in the results that characterizes sales-response-to-advertising research justifies further investigation in this area.

3.3.1.1 Lottery Sales Drivers

As it was noted earlier and echoing what past research has indicated, advertising is not likely to be the unique determinant of sales. To control for sales drivers, studies on the sales–advertising relationship have used, in addition to an advertising measure, other promotion mix, marketing mix, demographic, and socio-economic variables. Thus, the appropriate evaluation of the effect of advertising requires a researcher to factor in other additional elements in a model, since sales may also depend on those variables (Albion and Farris, 1981). Using previous lottery studies and general sales-advertising relationship research as reference, and taking the data availability factor into consideration, we decided to include jackpot size, unemployment rate, and state population as independent variables, in addition to advertising expenditures, to explain sales in the models we will use in the present investigation. We discuss each one of these variables next.

Advertising Expenditures

Advertising has been defined as paid nonpersonal communication from an identified sponsor using mass media to persuade or influence an audience (Wells et al, 1995). As we mentioned earlier in this chapter, the relationship between advertising and sales has been investigated for several decades. Authors like Bass and Parsons (1969), Clarke, (1976), Kyle (1978), Weinberg and Weiss (1982), Weiss and Windal (1980), and Deighton et al. (1994), Little (1979), Hanssens (1980), Wilkie and Moore (1999), Mizerski et al. (2001), Heiens (1993), Borg and Stranahan (2005), Stone (2000), and Zhang (2004) to mention a few, have studied the sales-advertising relationship. The results of their efforts, however, as we have indicated before, have yielded contradictory conclusions regarding the sales effectiveness of advertising, with some studies suggesting that advertising is highly effective while others concluding it is a waste of money.

Measuring the influence of advertising on sales is a complicated task. Such difficulty derives from the fact that isolating the advertising effect on sales from the effect of many other variables is not easy. Additionally, as we will explain ahead in this chapter, issues such as the cumulative effect of advertising on sales (Bass and Parsons 1969), and the shape of the sales-response-to-advertising curve have been the subjects of considerable controversy among researchers throughout the years. To complicate matters further, past investigation has suggested that the sales response to advertising varies widely from product to product, which renders generalizations about the sales-advertising behavior unfeasible (Vidale and Wolf 1957). Given the importance of the above issues, we discuss each one in detail in separate sections ahead in the present chapter.

Jackpot Size

Past research has consistently suggested that jackpot size is strongly and positively related to lottery sales. In other words, the greater the jackpot, the larger the game sales. Research by Akay (2007), DeBoer (1990), Mikesell and Zorn (1988), Garrett and Sobel (2002), Cook and Clotfelter (1993), Depken and Dorasil (2007), and Lyons and Ghezzi (1995) all have arrived at the same conclusion that larger jackpot sizes results in increased wagering. DeBoer (1990) and Garrett and Sobel (2002) also suggest that the relationship between jackpot size and sales may be nonlinear. According to these authors, sales accelerate as jackpot rises, which implies that the sales response to jackpot size (jackpot sales elasticity) increases with larger jackpots.

Unemployment Rate

Empirical evidence seems to indicate that economic conditions may affect lottery sales. Vrooman (1976), for instance, found that increases in unemployment and decreases in income increase lottery sales. Mikesell's investigation (1994) also found a positive association between lottery jackpot and lottery sales; his study suggested that as state unemployment rates increase, more people may find the small chance of winning the lottery more attractive than when unemployment rates are lower. This last conclusion is also supported by the results obtained by Heavey (1978), Vasche (1985), and Mikesell and Zorn (1987). However, Akay (2007), Stone (2000), Walzer et al (1977), and DeBoer

(1990) arrived at differing conclusions. DeBoer (1990) found no significant relationship between lottery sales and unemployment rate. Akay (2007) found that unemployment only influences lottery sales for larger lotteries. Stone's study (2000) suggested that as the unemployment level in a state decreased, lottery revenue increased. Walzer and Schmidt (1977) in a population-sales cross-sectional study confirmed Stone's findings (2000) since their research suggested that unemployment and sales showed a significant negative association; in other words, as unemployment increases, lottery sales decrease.

State Population

Liu (1970) in his investigation of retail sales determinants analyzed, among other things, the relationship between retail sales and population. This researcher found a positive and statistically significant relationship between these two variables; in other words, the larger the population, the greater the sales. Also, in a cross-sectional study on population change and retail sales, Walzer and Schmidt (1977) found that population was positively related to sales per capita.

DeBoer (1986) analyzed the lottery sales-population relationship; in his investigation, this author makes an interesting analogy: the spread of lottery participation within lottery states is equivalent to the spread of an innovation to new users within a population. Thus, he uses an exponential model (also known as Power model) which, transformed into logarithmic form, becomes:

$$\text{Log (Sales)} = a + b.\text{Log(Population)} + k.\text{Time}$$

where a, b, and k are regression coefficients estimated through regression analysis.

After fitting this model to the data through regression analysis, this author found that the estimate of the population elasticity of sales parameter is significantly different from zero, which suggests that new lottery adoptions result in sales increases proportionate to the lottery state population increase (DeBoer 1986).

In a cross-sectional scale-economies-of-Lotto study, Cook and Clotfelter (1993) found that population size had a significant positive effect on Lotto sales. Their investigation yielded significant estimates of the elasticity of sales with respect to population ranging from 0.41 to 0.52. Such elasticity of sales figures suggest that, ceteris paribus, a one percent increase in population is associated with a 0.41 to 0.52 percent increase in sales.

3.3.2 Does Advertising have Current and/or "Carryover Effects" on Sales?

When addressing the issue of current and/or carry-over advertising effects on sales, we have to necessarily talk about an intrinsically associated issue: data aggregation. Discussion of the level of data aggregation in sales-advertising research is crucial since aggregation has been a frequent source of results discrepancy in sales-advertising relationship studies.

Researchers frequently have no control over data aggregation since the information to which they often have access has already been aggregated over geographic regions (i.e. entire countries), advertising media (i.e. television, radio, newspapers, etc.), and time (i.e. quarters or years) by its proprietor. A fair amount of investigation has been dedicated to understanding the time aggregation problem. The existing research suggests that estimates of advertising effectiveness and its lagged effects can change greatly if the advertising data are aggregated over periods (e.g. quarters, years) longer than the periods (e.g. months) for which decisions about advertising spending levels are made. Articles by Russell (1988) and Tellis and Weiss (1995) present informative analyses of this problem. The study carried out by these last two authors provides evidence (using data for a single consumer product) on how aggregation over time and households may incorrectly lead one to conclude that television advertising increases sales in the current period.

Among the studies supporting advertising's influence on sales, several indicate that its effects are short-lived while others suggest the contrary. Some researchers affirm that, while advertising has an immediate impact on sales, it also generates revenues during the subsequently short time periods after advertising has stopped; Aaker and Carman (1982) call this period the "short-run carryover effects", whereas Palda (1965) refers to it as "cumulative" or "lagged effects". In his article, Palda discusses the use of distributive lags proposed by L.M. Koyck in measuring cumulative advertising as a function of sales. For cumulative or lagged effects of advertising Palda means "the effects of a perceived advertisement that influences two or more successive purchasing decisions of a consumer with regard to a given product or the effects of an advertisement that influences consumer behavior." According to this author, the expression "distributed lags" defines a phenomenon in which a stimulus generates "a full reaction only after some passage of time. The total effect is not felt in the same period in which the cause occurred but is distributed over time." Palda also argues in this article that "the estimation of lagged effects of advertising is considerably improved and simplified when it is based on Koyck's assumption of distributed lags." This author also affirms that whereas "traditional" models that embody the concept of distributed lags employ a large number of exogenous variables, the simple Koyck model uses only one lagged and one non-lagged exogenous variable.

Tellis et al. (2000), who also investigated the above issue, found that ads have current and short term carryover effects on the number of referral calls; in their research, these authors used highly disaggregate data at the hourly level and a general distributed lag modeling approach to estimate the effects of direct television advertising on a toll-free referral service. Additionally, Dhalla (1978) pointed out that sales must be treated as a capital investment since advertising has a long term effect on sales. Jedidi et al. (1999), in a more recent study supported this point of view.

Leone (1995) found evidence suggesting that the effect of advertising on sales dissipated after a six-to-nine month period, thus, contradicting earlier findings by Assmus, Farley, and Lehman (1984) that supported a three-to-fifteen month period instead. Dekimpe and Hanssens (1995) asserted that advertising effects did not fade away in a year's period. An earlier study by Winer (1979) suggested that, during the same period, current advertising effects increase, while carryover effects decline over time. Clarke (1976) argued that the long-term effect implied by the annual data is largely overstated.

The issue of the duration of advertising effects has important managerial ramifications since it could help firms determine how much they need to spend in advertising and how to spend it. A manager can ask, for instance: "Will this year's advertising affect next year's sales? If its effect continues, how much will the impact be diminished over time?" According to Albion and Farris (1981), estimates of the advertising carry-over effects and their duration depend on the industry studied, the time period used, and the research methodology employed; values can vary widely even within the same industry when different time periods are used in the analysis (data aggregation problem). The intricacy of the advertising carryover effects problem suggests that further research is needed in such regard.

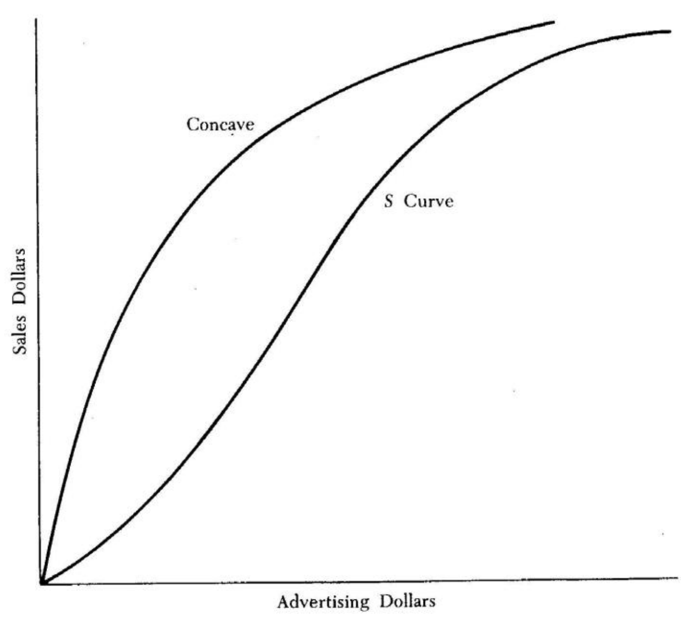
3.3.3 What Type of Curve Characterizes the Sales-Advertising Relationship?

To address the sales-advertising curve shape problem, we should begin by emphasizing that, while economists are primarily interested in the macroeconomic and social effects of advertising, marketing managers are mainly concerned with micro level issues such as sales, profit, or market share. Managers are constantly worried about, among other things, advertising overspending or underspending. What justifies their concerns is the fact that the effect of advertising on sales, market share and the prices of their products is difficult to measure. This makes their goal of increasing advertising expenditures until the profits produced by the last dollar of advertising equals to the cost of advertising (marginal cost = marginal revenue) hard to achieve. Managers frequently fail to attain this objective because the environment in which they develop their activities is dynamic and there are many other variables that could also influence sales, which complicates matters further. As past evidence has suggested and as it was noted earlier, advertising is not likely to be the unique determinant of sales; sales promotions, personal selling, in-store displays, and public relations are other forms of marketing communications that can also help management to communicate information about their products and provide purchasing incentives to consumers to affect sales. This makes it difficult for managers to isolate the impact of advertising expenditures on sales. Since advertising is another element of the promotional mix, to evaluate its effects it is important to factor in the other elements of the communications mix in a model, since sales may depend on those variables also (Albion and Farris 1981).

From an intuitive point of view, it is sound to affirm that, up to certain upper limit, higher advertising expenditures should result in higher sales. However, it is not so easy to tell how much incremental sales we would get as a result of different advertising expenditure levels because the sales-advertising relationship is of non-linear nature. This task can be facilitated by the use of known sales-advertising curves which, empirical evidence suggests, approximate the sales-advertising behavior (Leckenby. 2005).

Tull et al. (1986) and Albion et al. (1981) indicate that there are two general families of these curves that marketers frequently use to model the sales response to advertising: the S-shaped curves and the concave-downward curves. Each curve embodies a theory of how advertising works. The first one, the sigmoidal curve (S curve), is probably the most commonly used in marketing. According to the proponents of this curve, advertising spending is less efficient below certain threshold levels, and a critical mass of advertising weight is necessary for managers to obtain optimal returns from advertising. The second family, the concave-downward curve, has as its theoretical root the law of diminishing returns to productive inputs (Stigler 1961). According to this theory, at the aggregate level, the unreached prospects will have gradually weaker buying predispositions as advertising increases over the full advertising spending level range (Ozga 1960). At the individual buyer level, the reasoning is that a message conveys less and less information with each additional advertising exposure (Stigler 1961). In other words, a concave function implies that each additional advertising dollar spent produces less than the former dollar in sales revenue generated. Both the S and the concave curves are shown in Figure 3.1.

Figure 3.1: Sales-Advertising Relationship Curves (Albion et al. 1981).

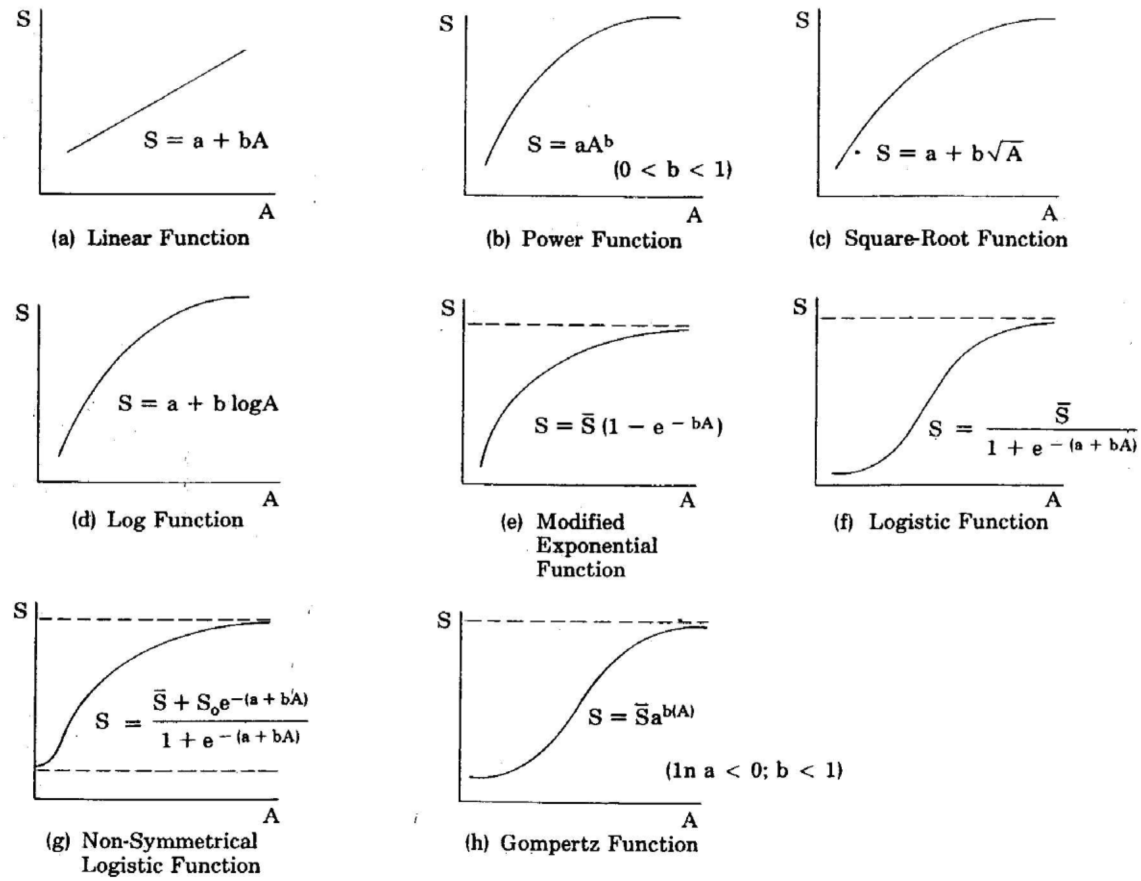


Albion et al. (1981) affirm that economists are concerned with the possibility of increasing returns to advertising expenditures at some spending levels because this is a main tenet of their argument that advertising creates market power. In their opinion, if large firms have an advantage over small firms because an advertising campaign becomes more efficient once it reaches a given scale, smaller firms as well as potential entrants into the industry incur higher costs until they reach that scale. They claim that this situation results in less competition and poorer resource allocation across industries. Marketers are also concerned about the existence of scale economies in advertising because of its implications for advertising budgeting. Marketing practitioners and economists, however, do not seem to agree on which curve better models reality. Although there is the extended belief that the S-curve more accurately models reality, it is important to note that, in recent years, the use of the concave-downward curve has gained supporters.

3.3.3.1 Functional Forms Used to Model Sales-Response-to-Advertising

To model sales-advertising relationships, we can use different functional forms. The specific functional form used determines the type of curve characterizing the sales–advertising (S-A) behavior. A list of functional forms employed in econometric studies is detailed below and they are also illustrated in Figure 3.2 (for the bivariate case), which can be used in sales response modeling, as described by Leckenby et al. (1982).

Figure 3.2: Response Functional Forms (Leckenby et al. 1982).



Linear Form

A linear function is mathematically represented as:

$$S = a + \beta_1(A) + \beta_2(U) + \beta_3(P) + \beta_4(J)$$

where, for the purposes of this dissertation:

S = sales and A = advertising; U = unemployment rate; P = state population;

J = Lottery Jackpot; and a, β_1, β_2, β_3 and β_4 are regression parameters.

This function indicates that each dollar spent on advertising is associated with β_1 dollars of sales, ceteris paribus, and "a" represents the sales level when Advertising expenditures are zero (plane intercept with the Sales axis). In this function, returns to scale are constant throughout the range of the function. The linear functional form can be useful, but only if it is used within a limited interval of the advertising domain since sales grow until they begin approaching an upper limit and then flatten out or decline. As mentioned before, the existence of this nonlinear sales-advertising behavior is supported by past research. Thus, when modeling the sales-advertising relationship using the linear form, a researcher deliberately ignores such nonlinear behavior.

Concave-Downwards Functional Forms

As mentioned before, all concave-downward and sigmoidal functional forms were incorporated into the sales-response-to-advertising research because the use of such functions allows us to more realistically model the sale-advertising behavior. In the case of the concave-downward functions, we assume diminishing returns to scale over the entire advertising domain. In other words, for each additional dollar spent on advertising we obtain progressively less returns in sales. Four commonly used functional forms fall into this category:

- Power Function

$$S = a(A)^{\beta 1} (U)^{\beta 2} (P)^{\beta 3} (J)^{\beta 4}$$

where a and βi are parameters; $0<\beta i<1$

In this function, different parameter (a and βi) combinations yield increasing ($\beta i > 1$), decreasing ($0 < \beta i < 1$), and ($\beta i = 1$) constant returns to scale. In this model, the parameters bi have the economic interpretation of elasticity (the percent change in sales, S, when there is a one percent change in advertising, ceteris paribus. The same interpretation applies to the parameters corresponding to Unemployment, Population, Jackpot, respectively. "βi" is generally positive for most marketing variables (Lillien et al, 2003).

For data fitting purposes, modelers transform the Power Function into a linear form by applying logarithms to both sides of the equation:

$$Ln(S) = Ln(a) + \beta_1 Ln(A) + \beta_2 Ln(U) + \beta_3 Ln(P) + \beta_4 Ln(J)$$

where S, A, U, P, and J > 0.

Such transformation enables the researcher to obtain a linear model which facilitates the fitting of the data using linear regression analysis.

-Square Root Function

$$S = a + \beta_1 \sqrt{A} + \beta_2 \sqrt{U} + \beta_3 \sqrt{P} + \beta_4 \sqrt{J}$$

The square-root function is simply a particular type of the Power function $S = a(A)^{\beta}$, where the parameter "a" is added ("a" represents sales at zero advertising, unemployment, population and jackpot) and the parameter $\beta = 1/2$.

- Log Function

$$S = a + \beta_1 Ln(A) + \beta_2 Ln(U) + \beta_3 Ln(P) + \beta_4 Ln(J)$$ where S, A, U, P, and J > 0.

This function successfully handles situations where constant percentage increases in advertising (or other variables) result in constant absolute increase in sales, ceteris paribus. It can be used to represent a response to advertising spending where, after some threshold of awareness, additional spending may have diminishing returns (Lillien et al, 2003).

-Modified Exponential Function

$$S = S'(1 - e^{a+\beta 1(A) + \beta 2(U) + \beta 3(P) + \beta 4(J)})$$

where S' = Maximum Sales limit a brand or firm can reach (upper asymptote).

The algebraic transformation to linear form of this function is:

$$Ln(1 - S/S') = a + \beta_1 (A) + \beta_2(U) + \beta_3(P) + \beta_3(J)$$

This function models situations where decreasing returns to scales might exist and has an upper bound or saturation level at S' and a lower bound of zero. In other words, the use of this function (and all other concave-downwards functions) assumes that each additional advertising unit increase is associated with progressively decreasing sales returns. Also, this last function assumes that sales cannot go below zero (sales cannot have a negative value) or above an upper limit because sales can only grow so much, up to a certain upper limit (saturation level), given the finite nature of the market.

Sigmoidal (or S-shaped) Functional Forms

As it was indicated earlier, S-shaped curves imply that for a certain range of advertising expenditure levels there are increasing returns to scale (which corresponds to the initial concave-upward part of the curve). Then, an inflexion point is reached and, from then on, any additional advertising expenditure generates only progressively diminishing returns to scale (concave-downward part of the curve).

Three commonly used functional forms have these characteristics:

-Logistic Function

$$S = (S') / (1 + e^{-(a+\beta1(A) + \beta2(U) + \beta3(P) + \beta4(J))})$$

where S' = upper asymptote.

The algebraic transformation to linear form of this function is:

$$Ln[S / (S' - S)] = a + \beta_1 (A) + \beta_2(U) + \beta_3(P) + \beta_3(J)$$

The logistic form is probably, among the S-shaped models, the most commonly used function. This function has a saturation level at S' and a lower bound of 0

- Non-symetrical (Lower-Bound) Logistic Function

$$S = (S' + So.e^{a+\beta1(A) + \beta2(U) + \beta3(P) + \beta4(J)}) / (1 + e^{a+\beta1(A) + \beta2(U) + \beta3(P) + \beta4(J)})$$

where So = lower asymptote.

The algebraic transformation to linear form of this function is:

$$Ln[(S' - S) / (S - So)] = a + \beta_1 (A) + \beta_2(U) + \beta_3(P) + \beta_3(J)$$

The Lower-Bound Logistic Function behaves similarly to the logistic function but is has a lower bound = So. In other words, Sales will always fall between S' (upper bound) and So (lower bound).

-Gompertz Function

$$S = S' e^{-\mathbf{e}\ \wedge\ (a+\beta1(A) + \beta2(U) + \beta3(P) + \beta4(J))}$$

where S' >0

The algebraic transformation to linear form of this function is:

$$\text{Ln}\,[\text{Ln}\,(S') - \text{Ln}\,(S)] = a + \beta_1\,(A) + \beta_2(U) + \beta_3(P) + \beta_3(J)$$

According to Lillien et al (2003), among the S-shaped functions, the Gompertz form is the less frequently used. Both logistic and Gompertz curves lie between a lower bound and an upper bound. These upper and lower bound restrictions on sales are realistic and justified since even with no advertising a firm may get some sales (lower bound); also, as we mentioned before, sales cannot increase indefinitely because the market is finite and, hence, beyond certain point further increase in advertising expenditures cannot not yield more sales (saturation level).

Addressing the issue of the shape of the sales-advertising curve requires testing different functional forms on a general sales-response model. Two major sales-response model alternatives are discussed next.

3.3.3.2 Sales Response Models

To deal with the advertising effects, their nature, and the duration issues we discussed earlier, two general models (among several available described in the literature) can be used (Leckenby 2005):

-Current Effects Model, and

-Koyck's Model

Current Effects Model

The Current Effects model takes only into consideration, as its name suggests, the current effect of advertising expenditures on sales, and it is expressed in its simplest (linear) form as follows:

$$S_t = a + \beta_1 (A_t) + \beta_2(U_t) + \beta_3(P_t) + \beta_3(J_t) + e_t,$$

where S_t =sales at period t, and A_t, U_t, P_t, and J_t represent Advertising Expenditures, Unemployment, Population and Jackpot at period t. "a" and "β_1" (i = 1 to n observations) are regression coefficients.

The most commonly used nonlinear versions of the Current Effects model were already described in detail in the last section (Functional Forms Commonly Used to Model Sales-Response-to-Advertising). Thus, we refer the reader to that section for further information.

Koyck's Model

Koyck, (1954) proposes that Sales at period t are a function of geometrically declining advertising expenditures (current period and previous periods). The simplest (linear) untransformed version of Koyck's model is described below (using the bivariate case, for simplicity):

$$S_t = a + \beta (A_t) + \beta \lambda A_{t-1} + \beta \lambda^2 A_{t-2} + \dots$$

where a and β are regression coefficients, λ= carryover rate, and A_{t-1}, $A_{t-2,}$ etc. are the advertising expenditures in the periods prior to the current period t. Koyck's geometric lag-scheme implies that more recent values of advertising (A_t) exert a greater influence on sales than more distant values of advertising. Thus, according to Koyck, the lag coefficient of this model decline in the form of a geometric progression as defined by the expression: $\beta_i = \lambda^i(\beta)$

In order to overcome the difficulty of knowing how far back in time the advertising terms needed to go, Koyck manipulated the above model algebraically and transformed it into the following expression:

Koyck's Linear Model

$$S_t = (a - a\lambda) + \beta\,(A_t) + \lambda S_{t-1}$$

where, the parameter "λ" represents the constant carryover rate.

As seen above, Koyck's model suggests that the effect of the advertising carried out in preceding time periods (A_{t-1}, A_{t-2}, A_{t-3}, etc.) on current sales (S_t) can be summarized in the lagged sales (S_{t-1}) (Leckenby, 2005). This model, hence, will lead us to the determination of the duration of the advertising effect.

We obtain the seven nonlinear versions of the Koyck's model we plan to use in the present dissertation by simply substituting the S_t and S_{t-1} variables with the corresponding transformation function in each one of the indicated forms. Thus, the nonlinear adaptations of Koyck's model in the respective linearized forms are:

Koyck's Logistic Model:

$$Ln[S_t / (S' - S_t)] = a + \beta_1(A_t) + \beta_2(U_t) + \beta_3(P_t) + \beta_4(J_t) + \beta_5 Ln\,[S_{t-1} / (S' - S_{t-1})]$$

Koyck's LB Logistic Model:

$$Ln[(S' - S_t) / (S_t - So)] = a + \beta_1(A_t) + \beta_2(U_t) + \beta_3(P_t) + \beta_3(J_t) + Ln[(S' - S_{t-1}) / (S_{t-1} - So)]$$

Koyck's Modified Exponential Model:

$$Ln\ [1 - S_t / (S')] = a + \beta_1(A_t) + \beta_2(U_t) + \beta_3(P_t) + \beta_4(J_t) + \beta_5 Ln\ [1 - S_{t-1} / (S')]$$

Koyck's Power Model:

$$Ln\ (S_t) = Ln\ (a) + \beta_1 Ln\ (A_t) + \beta_2 Ln(U_t) + \beta_3 Ln(P_t) + \beta_4 Ln(J_t) + \beta_5 {*} Ln\ (S_{t-1})$$

Koyck's Gompertz Model:

$$Ln\ [Ln(S') - Ln\ (S_t)] = a + \beta_1\ (A_t) + \beta_2(U_t) + \beta_3(P_t) + \beta_4(J_t) + \beta_5 Ln\ [Ln(S') - Ln\ (S_{t-1})]$$

Koyck's Logarithmic Model:

$$S_t = a + \beta_1 Ln\ (A_t) + \beta_2 Ln(U_t) + \beta_3 Ln(P_t) + \beta_4 Ln(J_t) + \beta_5(S_{t-1})$$

Koyck's Square Root Model:

$$S_t = a + b1(\sqrt{A_t}) + b2(\sqrt{U_t}) + b3(\sqrt{P_t}) + b4(\sqrt{J_t}) + b5(S_{t-1})$$

As an advancement of what is to come in the next chapters, we should note that we will fit all the previous Current Effects and Koyck's Models to our data; the models found to provide the best fit will be used for prediction purposes and to answer this study's research questions. This analysis selection process will be carried out and explained in detail in Chapters 4 and 5.

Upon discussing the carryover effects of advertising and the shape of its sales response curve, it is important to succinctly talk about the product life cycle, since the effect of advertising on sales seems to be influenced by the product life cycle. We do this next.

3.4 The Product Life Cycle

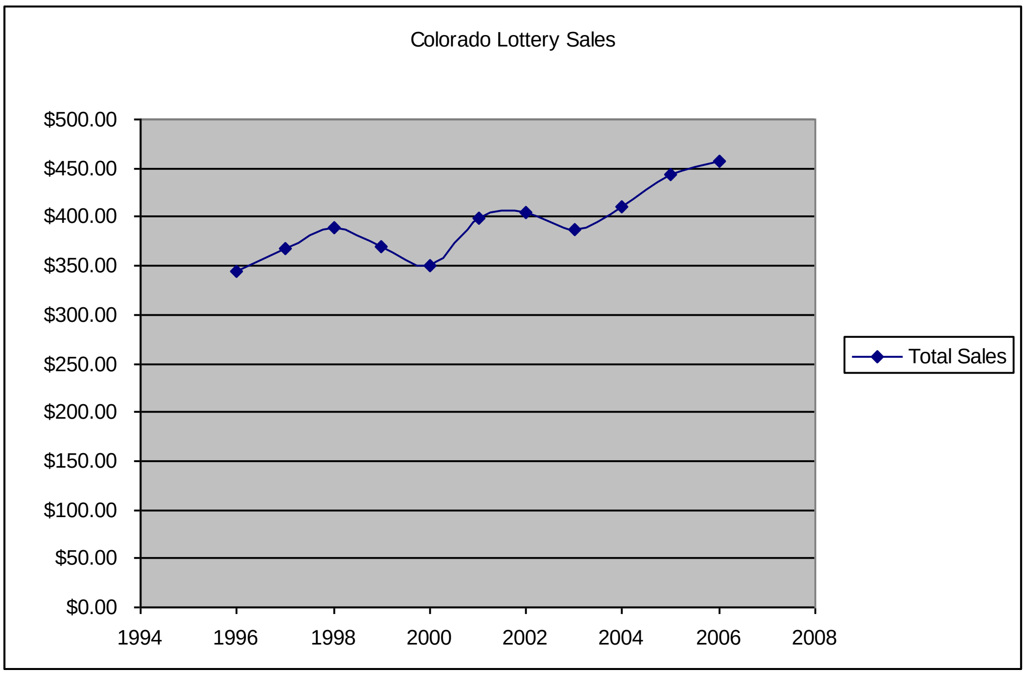
It is well known that a firm needs to adapt its marketing strategy over time due to, among other factors, changes in the demand of its products. The product life cycle concept is a useful tool to understand the strategic implications of the indicated changes.

The product life cycle represents the evolution of sales over time. This pattern has been divided into the following four stages (Guiltinan et al., 1999):

1. Introduction. In this stage, the product is new to the market and, hence, buyers need to be educated about the benefits offered by the product, its use, the potential user, and where to buy it.
2. Growth. The product is now more widely known, and its sales grow rapidly because new buyers enter the market, and increasing the market share is a crucial marketing task.
3. Maturity. In this stage, sales growth levels off since most potential buyers of the product have entered the market. Consumers are knowledgeable about the alternatives, repeat purchasers dominate sales, and product innovations are restricted to minor improvements.
4. Decline. During this phase, sales slow decline because of changing buyer needs or because of the introduction of new products that are sufficiently different to have their own life cycle.

Generally, product life cycle patterns are shown as having an "S" shape form. However, research by Rink and Swan (1979), Cox (1967), Buzzell (1966) report scalloped life-cycle patterns, representing a succession of life cycles (rejuvenations) generated by new product characteristics (redesigns), new uses, or new markets (Lillien et al. 2003).

Figure 3.3: Total Colorado Lottery Sales.



The accompanying Colorado Lottery sales plot is an actual example of the indicated pattern (see Figure 3.3).

The product life cycle shows how sales grow for a while at varying rates, level off, and then are usually replaced by some newer form of the product (with a distinct life cycle of its own). Mickwitz's (1959) suggests that the relative elasticities of marketing instruments change throughout the product life cycle. He indicates that in the introductory and growth phases, advertising elasticities are among the two highest (compared to quality, price, packaging, and service) meaning that advertising has the highest impact on sales during these stages.

Kotler ((1971) also asserts that one packaged goods company found that for a wide range of its products, advertising elasticity fell as the products passed through their life cycles. These findings can help management allocate the marketing budget to different marketing instruments at different phases of a product life cycle.

The product life-cycle concept is important because, by using it, firms can anticipate how sales might evolve for a product, and they can develop strategies to influence those sales. Thus, for instance, in the introductory stage, the firm should devote considerable resources to advertising to increase customer awareness of the new product. In the mature stage, the firm should devote resources to differentiating and positioning its offerings.

As indicated in the first chapter, the Colorado Lottery offers four games. Scratch is the oldest game among them (22 years-old at the end of FY 2004) since the first Scratch ticket was sold in January 1983. The Colorado Lotto was 16 years-old at the end of FY 2004 since it began selling in January 1989. Cash 5 was launched in 1996; hence, it was approximately 9 years-old at the end of FY 2004. Finally, the Colorado Lottery began participating in the mega-jackpot game Powerball on August 2001; thus, it was 4 years-old at the end of FY 2004.

Mikesell et al. (1987) and DeBoer (1990) indicate that lottery sales tend to peak after 10 years of operation. Using this criterion as a reference, we infer that the Colorado Scratch and Lotto games have already passed the maturity stage of their life cycles. Cash 5 is in the maturity stage, and Powerball, according to the above criterion, might be at the introductory stage of its life cycle. Since we only have access to four years (FY 2001 to FY 2004) of game sales information, plotting such data only allowed us to see a short fraction of the life cycle of each game, as shown on Figure 2.1. Thus, the pictorial representation of the Colorado Lottery games' life cycle is incomplete given the considerably short period covered by the sales data obtained for this investigation. Despite this limitation, the plot seems to suggest that Lotto is in the declining stage of this game life cycle since its sales show to be consistently decreasing over time, probably as a result of changing buyer needs, the introduction of new games, or due to the rejuvenation of old ones. Cash 5 seems to have reached a sales plateau, suggesting this game is going through the maturity stage of its life cycle given that, at 9-years old, most of its potential buyers have already entered the market. Powerball's sales curve shows that during his first four years of operation, this game has experienced a small initial sales decrease followed by a small sales increase and, again, a small sales fall with an annual average sales gain of only 0.77 percent over the indicated four-year period. Although the corresponding plot does not show a clearly defined sales pattern, the sales numbers suggests that Powerball seems to be slowly going through the introduction stage of its life cycle which, given the age of this game (4 years), is consistent with what would be expected at the introductory stage of a lottery game's life cycle, as explained before. Powerball sales behavior seems to confirm findings by DeBoer (1986), Vasche (1985), Mikesell and Zorn (1987) and Stover (1987) who agree that lottery sales initially rise, reaching a maximum when the lottery is approximately 10-years old (Mikesell 1987) and, then, begin to decline due to market forces.

Finally, the Scratch game curve indicates that sales have been consistently growing over the period analyzed. Giving the age of this game (22-years old), this trend appears to indicate that Scratch games sales are going through a rejuvenation process likely to have been brought about by recent game innovations and renewed marketing efforts implemented in recent years by this lottery organization. It is important to note here that the life-cycle interpretations and the analyses carried out in the present study, in general, are developed under the assumption that the effect that competing Colorado lottery games might have on the sales behavior (and, hence, life cycle) of the four Colorado Lottery games is negligible. We made the decision to work under such assumption to circumvent the inherent complexities that can result when competitive effects are taken into consideration in a study of this nature.

3.5 SUMMARY

In Chapter 3, we presented an explanation of how advertising works and discussed the factors that may influence impulse buying, which characterizes lottery products purchases. We also reviewed past research on sales-advertising relationship and discussed its most important issues. Finally, we discussed two general sales-response models and eight functional forms which can be used in sales-advertising research.

In Chapter 4 we will state the research questions driving the present lottery investigation and detail the research methodology we plan to use to address them.

Chapter 4: Research Methodology

This chapter begins by formally stating the research questions and corresponding hypotheses we need to test to appropriately model, and in the process better understand the sales-advertising relationship for Colorado Lottery games. We then detail the variables that, in addition to advertising, we plan to use to explain lottery sales. Next, we discuss the data set to be utilized in this study. Finally, we describe in detail the statistical methodology to be used to address this dissertation's research questions.

4.1 Research Questions and Hypotheses

The first step towards the achievement of the objectives of this investigation is the articulation of the overarching research questions that drive the present investigation. As it was mentioned in previous chapters, these questions are:

1) Is there a relationship between lottery sales and advertising expenditures?

If such relationship exists,

2) Does advertising have current and/or "carry over" effects on sales?

and,

3) What is the shape of the curve that characterizes the sales-advertising relationship?

It was noted in Chapter 2 that from FY 2001 through FY 2004 the Colorado Lottery marketed four games: Lotto, Cash 5, Scratch games, and Powerball. This investigation addresses the above three questions for three of those four games: Lotto, Scratch and Powerball. Cash 5 was excluded from this analysis since, during the above indicated period, the Colorado Lottery did not allocate any money to advertise this game. According to management, the Cash 5 advertising elasticity is very low to justify any advertising expenditure. Thus, the hypotheses associated with the research questions driving this study corresponding to each of the above Colorado Lottery games can be stated as follows:

Lotto Hypotheses

H1a: There is a statistically significant relationship between Lotto advertising expenditures and Lotto sales.

H1b: There is a statistically significant Lotto advertising carry-over effect on Lotto sales.

H1c: The relationship between Lotto advertising and Lotto sales is nonlinear.

Powerball Hypotheses

H2a: There is a statistically significant relationship between Powerball advertising expenditures and Powerball sales.

H2b: There is a statistically significant Powerball advertising carry-over effect on Poweball sales.

H2c: The relationship between Powerball advertising and Powerball sales is nonlinear.

Scratch Hypotheses

H3a: There is a statistically significant relationship between Scratch advertising expenditures and Scratch sales.

H3b: There is a statistically significant Scratch advertising carry-over effect on Scratch sales.

H3c: The relationship between Scratch advertising and Scratch sales is nonlinear.

4.2 Variables Used in this Study

To test the above hypotheses the present investigation will employ regression analysis. As we mentioned in the lottery sales drivers section of the literature review (Chapter 3), we chose to use as independent variables Unemployment Rate, State Population, and Jackpot size (Jackpot size is used only in the Lotto and Powerball games), in addition to Advertising Expenditures to explain lottery sales in our regression models. The indicated variables were chosen by using past sales-response-to-advertising research and data availability considerations as selection criteria.

4.2.1 Dataset and Variable Operationalization

Since there is persuasive evidence (Clarke 1976) indicating that monthly and quarterly data generate more accurate results than annual data when it comes to the determination of the duration of the cumulative effect of advertising, this investigation will employ monthly data on all the variables considered (Sales, Jackpot Size, Advertising Expenditures, Unemployment Rate and State Population). A total of 48 monthly observations (from July 2001 to June 2005) for each of the above variables were used in the present study. It is relevant to point out here that the Colorado Lottery provided weekly sales (in dollars) for its four games, and weekly jackpot size figures (in dollars) for the Lotto and Powerball games. We aggregated these data into a monthly format to match the aggregation level of the advertising expenditures data (in dollars) facilitated by the above Lottery organization.

The State of Colorado seasonally adjusted monthly unemployment rate data for the indicated period were obtained from the Colorado Department of Labor and Employment, whereas the U.S. Census Bureau provided the State of Colorado population estimates. The monthly advertising-related expenditures data made available to us by the Colorado Lottery corresponded, respectively, to: 1) Game-specific advertising expenditures; 2) point-of-sale advertising expenditures; 3) corporate advertising expenditures; 4) Colorado Lottery website-related expenditures; and 5) promotions-related expenditures. Since point-of-sale advertising expenditures, corporate advertising expenditures, website-related expenditures, and promotions-related expenditures were often, in the period studied, individually smaller than game-specific advertising, and since such expenditures sometimes fluctuated widely from month to month, it was decided to form another advertising-related variable adding all the five indicated advertising-related expenditures for each game. We called this new composite variable (Game) Aggregate Advertising. Thus, our study included two different advertising variables: Game-specific advertising and (Game) Aggregate advertising. The reason for doing this was to test all the above hypotheses using individually each of these two variables as the "advertising" variable in the regression models. This means that we have, actually, two sets of hypotheses (nine per set): one set involving the game-specific advertising and game-specific sales, and the other set of hypotheses involving the composite “aggregate” advertising and game-specific sales.

4.3 METHODOLOGY

We decided to use multiple regression analysis as the most appropriate technique to study the sales-advertising relationship in the lottery case. Past econometric research and the characteristics of the data to which we had access determined this decision. Thus, we test each one of the hypotheses proposed at the beginning of this chapter using this statistical technique.

In the Sales-Advertising Relationship section of Chapter 3, we explained in detail, from the theoretical point of view, how the three fundamental research questions that motivated this dissertation could be addressed. Thus, based on that discussion, for each game, we will specify, fit, analyze and evaluate a group of eight different functional forms (one linear and the other seven non-linear (sigmoidal and concave downwards)) utilizing two general models: Current Effects and Koyck’s Model. We decided to test the seven nonlinear response models (in addition to the linear model) since, as discussed in the literature review, there is theoretical and empirical evidence supporting the existence of a nonlinear relationship between sales and advertising expenditures (and other variables).

To answer the three central questions of this study and test the corresponding hypothesis, we plan to follow a four-step model-building procedure: (I) Specification, (II)

Estimation, (III) Verification, and (IV) Validation. The nature of each one of these stages is described next.

4.3.1 Specification

Before proceeding with the model specification itself, it is important to first perform an exploratory analysis of the data. We begin by obtaining descriptive statistics of our data, and checking it for outliers since they could exert an undue influence on parameter estimates. Here, we define two data sets: one containing all the outliers (data set with 45 observations, since 3 observations must be set aside as a holdout sample for model validation purposes) and a second data set where outliers are excluded. Employing the larger data set (45 observations), we perform a correlation analysis on all our variables to examine the general characteristics and nature of the relationships among them.

Next, using the dependent and independent variables selected for this study, the eight functional forms and the two general models (Current Effects and Koyck's Model), we specify the individual models. This initial model-specification procedure constitutes the first step in our course of action for finding the best fit to the available data for each game, if a significant sales-advertising association exists. Since we have three (3) games, eight (8) functional forms, two (2) general models, and two (2) advertising expenditures variables, the number of regression models we need to specify is a total of 96.

Since, in the verification step of this model-building process, we need to compare the effect of the advertising variable (and the effect of the other independent measures) on sales, in the presence and absence of outliers, we will need to run the original 96 specified regressions twice in the estimation stage: the first time using the "outliers-in" data set and a second time using the "outliers-out" set. This means that we need to run 192 regressions in the estimation stage of this model-building process.

The above-described specification procedure will help us determine what the general nature of the sales response function will be for each game (Leckenby et al. 1982). In other words, this particular process will enable us to put in testable form a theory of how advertising works for each lottery game which, essentially, constitutes the central and encompassing objective of the of the present dissertation.

4.3.2 Estimation

The estimation of the parameters of the response functions under consideration is the second step in the model-building process. Such goal, as mentioned earlier, will be achieved by performing the regression analyses themselves on the set of variables selected for this study. As we noted earlier, these variables are:

Dependent Variable:

Lottery Sales (Y). Monthly lottery-game specific sales

Independent Variables:

Monthly Colorado Population (P)

Seasonally Adjusted Monthly Colorado Unemployment Rate (U)

Game-specific Advertising (A), which encompass the monthly media and production costs of advertising the specific lottery game; and Game Aggregated

Advertising (A'), which is a composed advertising-related variable, as it was explained earlier.

Monthly Jackpot (J), which is the average jackpot sum corresponding to Lotto or Powerball

As we mentioned before, we will use time-series data corresponding to 48 months of business activity of the Colorado State Lottery. The information on the first (earliest) 3 months, however, will be saved to be utilized as a hold-out sample in the model-validation stage (the fourth step in the model-building process). Thus, as we briefly pointed out in the specification stage, we will run the corresponding 96 regression procedures on both the 45-observation data set and on the "no-outliers" data set.

Since we are dealing with regression of time-series data, there is the possibility that we might run into a violation of the independence-of-errors assumption. If such situation arises with the Current-Effects Model, we will use Koyck's model instead to try to overcome the autocorrelation problem and, thus, obtain from it the answers to both the first and second questions driving this investigation. To test for autocorrelation on the Koyck's model we will use the Durbin-Watson test since Monte Carlo results reported in the literature indicate that such test performs well in the presence of one lag of the dependent variable, which is the case of Koyck's model (Dezhbakhsh 1990, Heiens 1993).

Once the eight regression analyses are run for the three games, using the eight functional forms, the two general models, the two advertising variables (game specific and aggregated advertising), and the two data sets (with and w/o outliers), this procedure will yield 192 sets of regression parameter estimates with their respective test statistics. Such results will be detailed in Appendix tables for model comparison in the verification stage.

4.3.3 Verification

This stage deals with the analysis of the results of the statistical tests performed on the parameter estimates to obtain an idea about their validity. In this instance of the model-development process, we will evaluate the adequacy of each model. As noted before, the Appendix Tables 1 through 24 will show all the information needed to compare the models considered. The evaluation criteria used for the verification of the models are the following (Leckenby 2005):

- The significance of the regression coefficients (only models showing a statistically significant sales-advertising relationship will serve our research purposes and, hence, will justify further examination)
- A low residual sum of squares (RSS) value and/or high R square.
- Autocorrelation test results (as suggested by a non-significant Durbin-Watson statistics), since autocorrelated data obscure the true nature of the relationship between the variables studied.
- Ease of model interpretation, to facilitate their use by management.
- Models should make sense (predicted values must be logic).

After applying the above criteria to all the models on each game, the best two models will be selected, for each of the three games, for further evaluation in the validation step of the model-building process.

4.3.4 Validation

This is the final step in the model development process. Here predictions will be made using the two indicated models on the hold-out sample. Utilizing the absolute value of the difference between the predicted and actual sales for each of the three remaining observations, we will compute the average percent error (APE) for each model chosen according to the following equation:

$$APE = (1/n)\Sigma\ [100 \text{ x } |\text{Actual Value}_i - \text{Predicted value}_i| \ / \ \text{Actual Value}_i]$$

where $i = 0$ through n; n = number of observations in the holdout sample.

This percentage is expected to be less than or equal to 5 percent to be considered acceptable (Leckenby, 2005). This is what is known as the "acid test." In the validation stage, we will select the model that would yield the lowest APE. This will be our final model and the one that best describes the relationship among Sales, Advertising and the other variables. This model is the one management could use for actual predictive purposes.

4.4 SUMMARY

In this chapter we outlined the research methodology to be used to address the three questions driving the present investigation. We began stating these research questions and the corresponding hypotheses; then, using past research and data availability considerations as reference, we proposed the variables to be used as independent variables in the models and discussed the time-series data set we had obtained for this research. Finally, we described the statistical methodology we planned to use to test the hypotheses we posed at the beginning of this chapter.

In the next chapter we will carry out the modeling of the sales-advertising relationship for each game following the procedure detailed throughout this chapter to obtain the corresponding predictive S-A models and, in the process, address the three fundamental questions driving this investigation.

Chapter 5: Results and Analysis

In the present chapter, we address the research questions driving this investigation by testing the corresponding hypotheses (which were proposed in Chapter 4). Upon completing the four-step model-building procedure ((I) Specification, (II) Estimation, (III) Verification, and (IV) Validation), we obtain the best sales-response-to-advertising model for each game (if a statistically significant sales-advertising relationship exists in each case), which is to be used for sales-predicting purposes.

Before we proceed, however, it is important to carry out an exploratory analysis to gain some insights about our data and about the relationships among the variables included in our study.

5.1 Data Exploration

Table 5.1 presents the most important descriptive statistics characterizing the data we plan to use for our analysis, which provide us with important central tendency and spread information.

Using a statistical package, we obtained histograms and Normal Q-Q plots for every one of the above variables. Such graphs suggested some deviation from normality in some of the series (this problem will be addressed when we transform the data by using the seven different functional forms). Through this exploratory analysis we also learned that several of the above variables contained outliers which could exert an undue effect on parameter estimates. We found five such extreme observations: two corresponding to Lotto Advertising Expenditures, two to Lotto Sales and Lotto Jackpot, and one corresponding to Powerball Advertising Expenditures. We took note of these data cases and excluded them from the original data set to form a new (no-outliers) data set which had 40 observations.

Table 5.1: Variable Descriptive Statistics

Variable	Minimum	Maximum	Mean	Std. Deviation
Population	4480475	4772576	4625066.87	87189.63
Unemployment	4.9	6.4	5.70	.35
Lotto Advertising	0	624735	81504.58	130683.37
Scratch Advertising	0	721453	232789.87	187057.87
Power Advertising	0	431017	119799.89	104257.20
Total Lotto Advert.	24122	788095	192295.76	151411.50
Total Scratch Advert.	18737	937382	343599.89	208054.27
Total Powerball Adv.	18554	560679	230653.09	117439.26
Lotto Jackpot (x 1000)	1468	9000	3495.89	1735.91
Powerb Jack (x 1000)	14790	114550	48148.51	26768.02
Lotto Sales (x 100)	27625	53699	36707.36	6205.15
Scratch Sales (x 100)	187193	259360	220304.40	17433.57
Power Sales (x 100)	44187	154674	65291.62	22979.69
Cash5 Sales (x 100)	10488	13381	11707.87	812.94
*Note: N=45				

In order to have an idea about which of the independent variables and, particularly, which advertising expenditures used in the present study were correlated with the respective games sales, we computed a correlation matrix (see Table 5.2).

Table 5.2 suggests that there exists a significant (at $\alpha = 0.01$) pairwise positive correlation (ρ=0.38) between Scratch Sales and Scratch Advertising, Also, according to the results shown on this table, Lotto Sales and Lotto Advertising, as well as Powerball Sales and Powerball Advertising are not significantly correlated. Also, Population is significantly correlated (at $\alpha = 0.01$), respectively, to Lotto Sales (ρ=-0.67) and to Scratch Sales (ρ=0.53). Finally, this correlation analysis suggests that Unemployment is significantly and negatively correlated (at $\alpha = 0.01$) to Scratch Sales (ρ=-0.45).

The above exploratory data analysis provides us an idea of what we might expect from testing the hypotheses proposed in chapter 4. As explained in the last chapter, we use a consistent approach to build our sales-advertising models and, in the process, we test the respective hypotheses. First, for each lottery game, game-specific advertising and the other predictor variables: population, unemployment, and jackpot (when applicable) were used in a least squares regression equation where the respective lottery game sales was the dependent variable. Next, eight regression analyses were performed (one for each functional form), which yielded the corresponding test results indicating which predictors were significant (α <.05). Each regression analysis provided also the overall-fit test

Table 5.2: Correlation Analysis

	1	2	3	4	5	6	7	8	9	10	11	12	13
1.Population	1.00	-.29	-.072	.29	.10	-.21	.15	-.10	-.38	.24	**-.67	**.53	.14
2.Unemploym		1.00	*.30	-.22	**-.40	0.24	-.21	*-.37	.06	.20	.11	**-.45	-.05
3.LottoAd			1.00	*-.31	*-0.37	**0.90	-.25	-.29	.20	-.04	-.13	-.23	-.15
4.ScratchAd				1.00	.07	-.20	**.95	.15	-.08	-.05	-.18	****0.38**	-.02
5.PowAd					1.00	*-0.37	.02	**0.82	.04	..07	*0.38	*.32	.28
6.TLottoAd						1.00	-.02	-.04	.18	.03	.19	-.28	-.04
7.TScratAd							1.00	.28	-.07	-.005	-.11	.29	.05
8.TPowerAd								1.00	.04	.20	.16	.19	*.36
9.LottJckK									1.00	-.28	**.89	*-.27	-.24
10.PowJckK										1.00	-.18	-.01	**.86
11.LottoSC											1.00	*-.38	-.06
12.ScratchSC												1.00	.10
13.PowerSC													1.00
*α ≤ 0.05	** α ≤ 0.01		N=45										

results, R-square estimate, the Durbin-Watson statistic to test if the errors were autocorrelated since, when that is the case, the significance of the regression parameter estimates becomes inflated. Finally, using only the models where advertising was: 1) a statistically significant sales predictor; and, 2) satisfied the other selection criteria described in chapter 4, we calculated the respective Average Percent Error (APE) employing our original holdout sample along with three more observations from the original data set,. Upon comparing R-squares and APE values for the models, we determined the best predictive model for each game. Next, we detail and discuss the results we obtained after performing the above-described model-selection procedure to address the research questions driving this investigation.

5.2 HYPOTHESES TESTING

5.2.1 Lotto Hypotheses

H1a: There is a statistically significant relationship between Lotto advertising expenditures and Lotto sales.

Using the Current Effects model to test this hypothesis we performed the eight regression analysis on the original 45-observation data set (see Table A1). We, then, proceeded to test this hypothesis using the aggregate Lotto advertising composite variable instead of the Lotto game-specific advertising we used initially (see Table A2). Next, we repeated the previous two steps but, this time, using the data set where the five outliers discovered in the exploratory data analysis were excluded, which yielded a 40-

observation data set (see Table A13 and A14). Thus, in total, we carried out 4 groups of eight regression analyses each (i.e. 32 regression analysis in total) to test this hypothesis. All these analyses yielded significant overall-fit (F) tests at $\alpha = 0.001$ significance level and no statistical evidence of autocorrelation. The R-Squares obtained ranged from 0.85 to 0.93, which indicates that the independent variables used (advertising, population, unemployment and jackpot size) explained from 85 to 93 percent of the variation on the dependent variable, Lotto sales.

Each one of the 32 regression analyses carried out to test the significance of the Lotto sales-advertising association consistently suggested that advertising was not a statistically significant predictor of Lotto sales in any of the models tested at both $\alpha = 0.05$ and $\alpha = 0.01$ significance levels, as shown on Tables A1, A2, A13, and A14. Such results are consistent with Heien's (1993), and Borg and Stranahan's (2005) findings. Our results contrast, however, with Stone's (2000) and Zhang's (2004) which suggest that the impact of advertising expenditures on lottery sales is statistically significant.

The non-significant sales-advertising association that characterizes the Lotto game could be the result of, among other things, its advertising budget limitations and the severe State restrictions imposed on the content of its advertising messages. These two factors probably precluded this marketing function from exerting a significant influence on sales.

The tests results corresponding to the regression analyses of the above 32 models consistently suggested also that there is a significant negative association between Lotto sales and Colorado population (Tables A1, A2, A13, and A14). These results imply that increases in population are associated with decreases in sales. Our findings contradict the results obtained by DeBoer (1986), Liu (1970), Walzer and Schmidt (1977), and Cook and Clotfelter (1993) who found a positive association between the above indicated variables.

The results of the 32 regression analyses additionally provide strong and consistent evidence of a significant positive association between Lotto jackpot and Lotto sales, which confirms research results obtained by Akay (2007), DeBoer (1990), Mikesell and Zorn (1988), Garrett and Sobel (2002), Cook and Clotfelter (1993), Depken and Dorasil (2007), and Lyons and Ghezzi (1995). In other words, larger Lotto jackpot sizes result in increased Lotto sales. This finding can be explained by using Lyons and Guezzi's argument (1995) that bigger jackpot sizes result in a positive association with increased Lotto sales because the average utility of a gamble increases compared to the cost of play.

Although the main objective of the present investigation is centered on the nature of the lottery games sales-advertising relationship, it is interesting to note that the low SSR and large R-Square values corresponding to the Gompertz model suggest that, among the 32 models tested, this sigmoidal functional form generates the best model fit for the Lotto game. The direct implication of this finding is that there is significant statistical evidence supporting the conclusion that, the relationship between Lotto sales and Colorado population and Lotto jackpot size seems to be best described by using the

Gompertz functional form (please, note that Lotto sales and advertising do not show evidence of any relationship). DeBoer (1990) and Garrett and Sobel's (2002) studies confirm our results since they found that the relationship between lottery sales and jackpot size seemed to be nonlinear.

With respect to the relationship between unemployment rate and Lotto sales, this study did not find any significant relationship between such variables in the 32 regression analysis we carried out. In other words, our research suggests that changes in the Colorado unemployment rate do not affect Lotto sales in any way. This result is consistent with DeBoer (1990) lottery study results and contradicts research findings by Vrooman (1976), Mikesell (1994), Heavey (1978), Vasche (1985), Mikesell and Zorn (1987), Akay (2007), and Stone (2000) who found that unemployment rate and lottery sales were related. The absence of a significant relationship between unemployment and Lotto sales seems to imply that the state economy, as reflected by its unemployment rate, appears not to have an impact on consumers' lottery purchasing decisions.

H1b: There is a statistically significant Lotto advertising carry-over effect on Lotto sales.

We tested this hypothesis using a procedure similar to the one detailed above. In the present case, however, we applied the eight functional forms to the Koyck's model since, as it was explained in the corresponding section, it allows us to detect advertising carry-over effects on sales. Here, the results of the 2 sets of 8 regression analyses each (one set using Lotto game-specific advertising and the other set using aggregated Lotto advertising as one of the explanatory variables) run on the 45-observation data set (see Tables A11 and A12) did not yield any significant association between Lotto advertising and current Lotto sales nor between lagged Lotto sales and current Lotto sales. Hence, no cumulative effect of advertising on sales seems to exist in the Colorado Lotto case. These non-significant results confirm Heiens' lottery study conclusions and contradict findings by Palda (1965), Tellis et al. (2000), Dhalla (1978), Jedidi et al. (1999), Leone (1995), Assmus, Farley, and Lehman (1984), Dekimpe and Hanssens (1995) and Winer (1979). The results of the same 2 sets of models run on the 40-observation data set (Tables 23 and 24) generated, however, some different and interesting results. Three regression analyses (Modified Exponential, Power, and Logarithmic Koyck models) from each of the 2 sets (game-specific and aggregate advertising cases; Tables 23 and 24) performed on the 40-observation data set did suggest both a significant relationship between lagged Lotto sales and (current) Lotto sales, and an absence of a current advertising and current sales relationship at $\alpha=0.05$. Since these two sets of three regression models performed equally well under the model evaluation criteria, for illustrative purposes, we chose the Power model from the original data set (outliers included) for further analysis, given its straightforward interpretation (see Table A23):

$$Ln(S_t) = 45.523 - 2.503Ln(P_t) - 0.011Ln(U_t) + 0.002Ln(A_t) + 0.239Ln(J_t) + 0.139Ln(S_{t-1})$$

As Table A23 shows, in this model, only the coefficient estimates corresponding to Ln(population), Ln(jackpot) and Ln(lagged sales) are statistically significant at $\alpha=0.05$.

Hence, in the above equation, the parameter estimate corresponding to $Ln(S_{t-1})$, known as λ (carry-over effect of all the independent variables), is statistically different from zero. As shown in the model above, $\lambda = 0.139$.

The P percent of the long-run impact on current Lotto sales of the independent variables of this model occurs in Ln(1-P) / Ln(L) periods (Koutsoyiannis 1984). Thus, in the present case, substituting values we find that the 90 percent of the long-run impact of the independent variables occurs in:

$Ln(1 - .9) / Ln(.139) = 1.17$ periods (months).

Since 90 percent of the long-run impact of the independent variables occurs in 1.17 months, which is slightly greater than one period (1 month), it can be concluded that the effect of the independent variables is mostly felt until the subsequent month.

It is important to note that the R-squares for the 32 models tested above ranged between 0.88 and 0.92, which suggests that 88 to 92 percent of the Lotto sales variation can be attributed to variations in the independent variables used to fit the data analyzed. Such high R-square values suggest an excellent fit.

H1c: The relationship between Lotto advertising and Lotto sales is nonlinear.

Since all the test results corresponding to the hypothesis H1a tests suggest the absence of a significant relationship between Lotto sales and Lotto advertising, there is no point discussing the shape of such relationship, for it does not exist.

5.2.2 Powerball Hypotheses

H2a: There is a statistically significant relationship between Powerball advertising expenditures and Powerball sales.

Using the same procedure we utilized to test the previous hypothesis, and based on the regression results shown on Tables A3, A4, A15 and A16, we conclude that there is no statistically significant association between Powerball advertising and Powerball sales. The consistent results of the 32 Current Effects regression analyses, again, agree with Heiens' (1993) and also with the results obtained by Borg and Stranahan (2005). They contrast, however, with Stone's (2000) and Zhang's (2004), which suggest that the impact of advertising expenditures on lottery sales is statistically significant. The rationale used to explain the non-significant relationship between Lotto Advertising and Lotto sales is also valid in the present Powerball case; thus, we do not include it here to avoid redundancy.

We should note that the tests of 10 out of the 16 Current Effect models corresponding to the 45-observation data set suggested the existence of a significant negative association between Powerball sales and the Colorado population; 6/8 Game-specific advertising models (Table 3) and 4/8 aggregate advertising models (Table 4) form this 10-model group, seventy percent of which falls into the sigmoidal category. These significant results contradict the findings obtained by DeBoer (1986), Liu (1970), Walzer and Schmidt (1977), and Cook and Clotfelter (1993) who found a positive association between sales and population. We must note that, interestingly, when we run the same 16 Current Effects models using the 40-observation data set (no outliers), the Powerball sales and Colorado population relationship disappeared, as shown in Tables A15 and A1. This suggests that the outliers excluded from the original dataset were determinant for the existence (or absence) of the Powerball sales and Colorado population relationship.

The results of the above 32 regression analyses (Tables A3, A4, A15 and A16) also provide consistent evidence of a significant positive association between Powerball jackpot and Powerball sales, which corroborate research results obtained by Akay (2007), DeBoer (1990), Mikesell and Zorn (1988), Garrett and Sobel (2002), Cook and Clotfelter (1993), Depken and Dorasil (2007), and Lyons and Ghezzi (1995). Each one of the 32 models tested suggested the existence of a significant positive relationship between Powerball sales and Powerball jackpot, which hints that larger Powerball jackpot sizes seem to result in larger Powerball sales. As we explained before, and using Lyons and Guezzi's argument (1995), increasing jackpot sizes result in a positive association with increased Lotto sales because the average utility of a gamble increases compared to the cost of play.

In regards to the relationship between Powerball sales and unemployment rate, the present investigation found a consistent significant negative relationship between such variables. Each one of the 32 models (Tables A3, A4, A15 and A16) led us to the same conclusion: larger unemployment rates seem to be associated with decreased Powerball sales. These results confirm Stone (2000) and Walzer and Schmidt's (1977) findings, which suggested a significant negative sales-unemployment relationship. Our results disagree with findings by Vrooman (1976), Akay (2007), Mikesell (1994), Heavey (1978), Vasche (1985), Mikesell and Zorn (1987), and DeBoer (1990). A possible explanation for our findings is that in periods of higher unemployment, consumers have fewer available resources which restrict their spending, with the consequent effect on their lottery purchases.

The R-squared values obtained from the above regression analyses ranged from 0.67 to .84, which suggests that 67 to 84 percent of the variation in Powerball sales is explained by the independent variables used in the above models.

H2b: There is a statistically significant Powerball advertising carry-over effect on Powerball sales

As the results shown on Tables A12, A13, A18 and A19 point out, there is no statistically significant association neither between current Powerball sales and current Powerball advertising nor between current Powerball sales and lagged Powerball sales with any of the 32 Koyck models fitted, which agrees with the conclusions at which Heiens (1993) arrived in his lottery study. Our findings, nevertheless, contrast with the results obtained, for other products, by Palda (1965), Tellis et al. (2000), Dhalla (1978), Jedidi et al. (1999), Leone (1995), Assmus, Farley, and Lehman (1984), Dekimpe and Hanssens (1995) and Winer (1979) who found evidence of advertising carry-over effect on sales.

H2c: The relationship between Powerball advertising and Powerball sales is nonlinear.

Since all the test results corresponding to the hypothesis H2a tests suggest the absence of a significant relationship between Powerball sales and Powerball advertising, a discussion of the shape of such relationship is not called for since it does not exist.

5.2.3 Scratch Hypotheses

H3a: There is a statistically significant relationship between the Scratch advertising expenditures and Scratch sales.

The regression analyses corresponding to Current Effects and game-specific advertising (Table A5) indicate that the Square-Root model is the only one in this set showing the presence of a statistically significant association between Scratch advertising and Scratch sales at the α=0.05 level. The corresponding regression analysis yielded a significant overall-fit (F) test result at α = 0.001 level and no statistical evidence of autocorrelation at α = 0.05. The R-Squared obtained was 0.40, which indicates that the independent variables used in this model (Scratch advertising, Colorado population, and unemployment rate) explain 40 percent of the variation on Scratch sales.

The regression analysis corresponding to Current Effects and aggregate advertising (Table A6) suggest, in contrast, that the Power and Logarithmic models are the only ones in this second set showing the presence of a statistically significant association between Scratch advertising and Scratch sales at the α=0.05 level. The corresponding regression analyses yielded, in each case, a significant overall-fit (F) test results at $\alpha = 0.001$ level and no statistical evidence of autocorrelation at $\alpha = 0.05$. The R-Squared values obtained from these two regressions were 0.41 in both cases. Such figure suggests that the independent variables used in these two models (Scratch aggregate advertising, Colorado population, and unemployment rate) explain 41 percent of the variation on Scratch Sales. The regression analyses run using the 40-observation data sample yielded exactly the same results as the ones detailed above for the game-specific and aggregate Scratch advertising, as shown on Current Effects Tables A17 and A18. These last results indicate that the presence or absence of the five outliers in the data set do not alter in any way the positive relationship between Scratch sales and advertising. The above findings are consistent with Stone's (2000) and Zhang's (2004) findings, which suggest that the impact of advertising expenditures on lottery sales is statistically significant. These results, nevertheless, contradict, Heiens' (1993) and Borg and Stranahan's (2005) conclusions regarding the lottery sales and advertising relationship.

The significant positive Scratch sales-advertising association found here could be explained by the fact that although Scratch is a 22-year old game, it has recently experienced a rejuvenation process brought about by renewed advertising and marketing efforts accompanied by creative game innovations implemented by the Colorado Lottery. In the opinion of this organization's management, such factors propelled the Scratch sales increase during the FY 2001-2004 period.

From the behavioral perspective, the positive Scratch sales – Advertising relationship can be explained using the Thinking-Acting-Feeling Hierarchy-of-Effects theory since such model appropriately explains impulse buying which, as explained earlier, characterizes lottery purchases. As noted in the literature review chapter, according to the proponent of this advertising theory, Krugman (1961), the manner in which consumers respond to and process advertising information is influenced by the level of the consumers' involvement with the advertising media and the product. In Krugman's opinion, broadcast media allows consumers very limited control over the timing and speed of the messages they receive. This author affirms that this lack of control may lead them to lower-level learning such as basic information storage; consumers, then, later might retrieve this information and use it in a purchasing decision. The Colorado Lottery allocates a large portion of its media budget (approximately 80 percent) to broadcast media. Using Krugman's theory as a referential framework, when Colorado consumers become exposed to lottery advertising broadcasted over television and/or radio, they have little control over the timing and speed of the Scratch advertising message to which they are being exposed. Such hard-to-control exposure may cause consumers' basic information storage; consumers, then, later on, might retrieve such information and use it in a Scratch ticket purchasing decision.

The tests results corresponding to the regression analyses of the above 32 models consistently suggested also that there is a significant positive association between Scratch sales and Colorado population (Tables A5, A6, A17 and A18). These results are consistent with those obtained by Liu (1970), Walzer and Schmidt (1977), DeBoer (1986) and Cook and Clotfelter (1993) who found a positive association between the indicated variables. This positive association may be explained by the fact that an increase in population in the state of Colorado is likely to generate an increased demand for Scratch tickets since more people probably implies a larger number of potential Scratch ticket buyers.

With respect to the relationship between unemployment rate and Scratch sales, this study found a significant negative relationship between such variables in the two groups (game-specific advertising and aggregate advertising) of Current Effects models (16 in total). These results suggest that larger unemployment rates seem to be associated with decreased Scratch sales. These results confirm Stone (2000) and Walzer and Schmidt's (1977) findings, which suggest a significant negative sales-unemployment relationship. Our results disagree with findings by Vrooman (1976), Akay (2007), Mikesell (1994), Heavey (1978), Vasche (1985), Mikesell and Zorn (1987), and DeBoer (1990). The rationale used to explain the negative unemployment-Powerball sales relationship can also be valid in this case.

H3b: There is a statistically significant Scratch advertising carry-over effect on Scratch sales.

The Koyck model regression results listed in Tables A7 (outliers included) and A19 (outliers excluded) suggest that there is a significant association between Scratch sales and game-specific advertising, in the case of the Square-Root model only. On the other hand, the Koyck model regression results listed in Tables A8 (outliers included) and A20 (outliers excluded) suggest that there is a significant association between Scratch sales and game-specific advertising, in the case of the Power and Logarithmic models. These results confirm our findings using the Current Effect models we discussed earlier in this section. However, the same 16 models suggest that there is no statistically significant association between lagged Scratch sales and (current) Scratch sales in any of the models fitted. This means that there is no statistical evidence supporting the existence of a carry-over effect of the independent variables of this model (including advertising among them). These findings agree with Heiens' (1993) and contrast with the results obtained by Palda (1965), Tellis et al. (2000), Dhalla (1978), Jedidi et al. (1999), Leone (1995), Assmus, Farley, and Lehman (1984), Dekimpe and Hanssens (1995) and Winer (1979).

H3c: The relationship between Scratch advertising and Scratch sales is nonlinear.

As the Current Effects models results indicated when we tested the hypothesis H3a, Scratch sales seem to be significantly associated with game-specific advertising, in the case of the Square-Root model only, as shown on Tables A5 and A17 (no outliers dataset). Our Current-Effects models results also suggested that Scratch Sales were significantly associated with aggregate Advertising, only in the case of the Power and Logarithmic models, as indicated on Tables A6 and A18 (no outliers dataset). Interestingly, the Square-Root, Power, and Logarithmic models all belong to the concave-down sales-advertising curve category; thus, we conclude that there is significant statistical evidence suggesting that the relationship between Scratch sales and Scratch advertising is best described by the concave-down curve, as opposed to the sigmoidal or linear models. Here, an explanation of this important result is germane. A concave-downward sales-advertising response curve implies that, at the aggregate level, advertising unreached prospects will have gradually weaker buying predispositions as advertising increases over the full advertising spending level range (Ozga, 1960). At the individual buyer level, under the concave-downward sales-advertising response paradigm, the reasoning is that a message conveys less and less information with each additional advertising exposure (Stigler, 1961). Thus, in the present case, and in a few words, a concave-downward Scratch sales-advertising response implies that each additional dollar spent on Scratch advertising produces less than the former dollar in Scratch sales revenue generated.

At this point, we face a final question: Which of the models best fits our data? As we concluded before, we have two final sets of Current Effects models to consider: 1) Square-Root model (game-specific advertising), and 2) Power and Logarithmic models (aggregate advertising). In the first case, we have only one model (Table A5); thus, there is no selection decision to be made. In the second case, we need to choose between the Power and the Logarithmic models (aggregate advertising). This decision requires us to use the “acid test” described in the validation stage of our selection process. Upon comparing the average prediction errors (Power model: APE=8.5 percent; and Logarithmic model: APE=8.4 percent) corresponding to these two models, we conclude that the Logarithmic model is the one that provides the best fit to our data since its APE is slightly lower. Thus, and to wrap up our study, we present next the resulting equations corresponding to these two final models:

- Square-Root Model (Scratch game-specific advertising):

$$\text{Scratch S} = -342{,}764.43 + 330.37*\sqrt{P} - 65{,}375.14*\sqrt{U} + 20.1*\sqrt{A}$$

In this model, as shown in Table A5, the coefficient estimates corresponding to all the independent variables are statistically significant. According to this model, ceteris paribus, a unit increase in the square root of advertising is associated with a $2010 increase in Scratch sales (since original sales data are expressed in $100 units).

- Logarithmic Model (aggregate advertising):

$$\text{Scratch S} = -5{,}828{,}521.96 + 397{,}230*\text{Ln}(P) - 74{,}029.26*\text{Ln}(U) + 6495.48*\text{Ln}(A)$$

Again, in this model all the independent variables are statistically significant, as indicated on Table A6. This model suggests that, everything else being kept constant, each one percent increase in advertising expenditures is associated with a $649,548 increase in sales.

Since the final goal of the present investigation was to synthesize a sales-advertising model, Colorado Lottery management could use the above equations to better understand the S-A behavior of the Scratch games for predictive purposes, to estimate optimal advertising expenditures, and using such knowledge, reduce operational inefficiency and develop better advertising strategies.

5.3 SUMMARY

In this chapter we have addressed the three fundamental research questions driving this lottery investigation. To do so, we tested the corresponding hypotheses using the methodology proposed in chapter 4 and, using the results from the corresponding statistical analyses, we obtained the answers to these investigation questions. In the Conclusions and Recommendations chapter of this dissertation, we will summarize the most important findings of this research endeavor, analyze their general implications, discuss the general limitations of this study, and suggest some possible future directions.

Chapter 6: Conclusions

In this final chapter, we summarize the findings made through this investigation and consider their possible implications. We also discuss the limitations of this research and propose some future directions.

6.1 Results

The present lottery modeling endeavor was driven by three fundamental research questions:

1.Is there a relationship between sales and advertising expenditures?

If such relationship exists,

2.Does advertising have current and/or "carry over" effects on sales?

and,

3.What is the shape of the curve that characterizes the sales-advertising relationship?

We addressed each one of these questions on three Colorado Lottery games: Lotto, Powerball, and Scratch games. The results we obtained from testing the hypotheses corresponding to these questions suggested that:

1. A statistically significant sales-advertising relationship existed in the case of the Scratch games. The two final Scratch models obtained through the selection process were:

- Square-Root Model (Scratch game-specific advertising):

$$\text{Scratch } S = -342{,}764.43 + 330.37*\sqrt{P} - 65{,}375.14*\sqrt{U} + 20.1*\sqrt{A}$$

and,

- **Logarithmic Model** (aggregate advertising):

Scratch S = -5,828,521.96 + 397,230*Ln(P) - 74,029.26*Ln(U) + 6495.48*Ln(A)

In the above models the coefficient estimates of all the independent variables were found to be statistically significant. Hence, advertising, population and unemployment, in both cases, play a role in explaining Scratch sales.

2. Carry-over advertising effects on sales did not appear to exist in any of the lottery games studied.

3. Since Scratch games were the only ones exhibiting a significant sales-advertising relationship, an analysis of the final models suggested that the concave-downward paradigm (as opposed to the sigmoidal or linear model) best fitted the respective data and, hence, it most appropriately described the Scratch sales-advertising behavior. This constitutes a new finding in lottery sales-advertising research.

Also, since we used unemployment rate, population and jackpot size (for Lotto and Powerball games only) as independent variables, in addition to advertising expenditures to explain lottery sales, we found statistical evidence supporting the existence of a negative population-sales relationship on the Lotto and Powerball games, while such relationship was positive in the case of Scratch games. We proposed some possible explanations for these results. We also found strong and consistent statistical evidence suggesting the existence of a negative unemployment-sales relationship for the Powerball and Scratch games, while such relationship seemed not to exist in the case of

Lotto. Furthermore, we found very strong and consistent statistical evidence suggesting a positive relationship between jackpot and sales in the Powerball and Lotto games, which confirmed previous findings.

6.2 Results Implications and Recommendations

The role of advertising as a sales-influencing factor was confirmed only in one (Scratch) of the three Colorado Lottery games investigated. As noted before, no sales-advertising relationship was found to exist in the case of the Lotto and Powerball games. Given the nonlinear nature of the sales-advertising relationship found to characterize the Scratch games, from the theoretical point of view, such finding extend prior empirical research that has generally assumed, for simplification purposes, a linear sales-advertising relationship, with its corresponding consequences. Additionally, the dissimilar sales-advertising relationship findings across games suggest that conclusions on advertising-sales behavior should not be generalized since sales-advertising behavior seems to be defined by factors internal and external to a game, advertising being only one of them. Additionally, the fact that all independent variables used to explain sales in both models proved to have statistically significant regression coefficients seem to confirm earlier findings suggesting that advertising is only one of several factors that can contribute to lottery sales.

Some of the practical implications of the present investigation is that its results confirm the appropriateness of the use of nonlinear models to fit sales-advertising data; this study provides managers with persuasive evidence about the problems they might run into when they use linear models as an approximation of their games' sales-advertising behavior, particularly if they use those models for advertising budget justification purposes. This study highlights advertising's contribution to sales which can help quell the long-established skepticism about its financial accountability.

Based on the above results, managers should avoid extrapolating game-specific knowledge to other lottery games, or even to the same game, if it is being offered in other state because socioeconomic, market, and demographic conditions could be different, which could generate a different sales-advertising behavior on that same game. Additionally, managers should take socioeconomic, demographic and market conditions, and game life-cycle characteristics into consideration when formulating games' advertising and marketing strategies since failure to do so can negatively impact their lottery operations.

The results of this investigation suggesting the absence of a sales-advertising relationship in Lotto and Powerball games only tells us that these games sales and advertising expenditures seem not to be associated. Such result, however, does not say anything about advertising's ability to move consumers across the advertising effects ladder, as explained by the hierarchy-of-effects advertising theory. Sales constitute only one measurement of advertising effectiveness; there are other advertising effectiveness measurements that managers should also consider when evaluating the contribution of this marketing communications function. Also, it is important to note that the absence of a sales-advertising relationship characterizing Colorado Lotto and Powerball could probably be explained by the fact that the advertising/sales ratio characterizing each of those games is only 2 percent. Relevant literature suggests that advertising/sales ratios below 5 percent are considered low. Thus, it is possible that such, comparatively, small advertising budget added to the State of Colorado strict restrictions on the content of the Lottery advertising messages might prevent that advertising have a significant effect on Lotto and Powerball sales.

Since jackpot consistently showed to have a strong positive relationship with lottery sales, managers should vigorously advertise it to promote Lotto and Powerball sales. There is abundant evidence from past studies supporting the strong sales-jackpot association.

6.3 LIMITATIONS

One of the most important limitations of this study is the small data sample to which we had access for our investigation. The period of operations covered with the data collected was short (48 months) to provide us with a reliable picture of the games' life cycles and satisfactory statistical testing power. The Lotto and Scratch games by the end of FY 2004 had been in operation for 16 and 22 years respectively; thus, four years of data was a very limited sample. Unfortunately, we had no control over this issue.

A second limitation is the way we had to measure lottery advertising and sales; we worked with game advertising expenditures and sales revenues (both in dollars) since they were our only choices; GRPs and number of tickets sold would have probably been a better alternative, since such units allow for a more accurate measurement of advertising and sales.

A third limitation is related to the fact that we run into some regression assumptions violations, particularly related to normality and homoscedasticity. Although transforming the data considerably reduced the extent of these problems, there was still some small non-normal and heteroscedastic behavior left in some variables which, we should note, could still be the source of biased test results. This study also included few independent variables, which probably prevented us from obtaining a more accurate description and a better understanding of the complex phenomena underlying sales-advertising behavior.

A fourth limitation is the fact that we did not use the Bonferroni correction when evaluating the regression coefficient test results. Since we performed 192 regression analyses in total, it is likely that some of the statistically significant results we obtained were the consequence of chance. To circumvent this problem, we should have tested each individual hypothesis at a statistical significance level of 1/n times what it would be if only one hypothesis were tested (α/n).

Interaction terms were not included in our models; such omission could have also had a detrimental effect on our results. We must note, however, that we were aware of such risk but still decided to take that chance given the small size of our dataset; the number of observations / number of independent variables rate was already lower than the recommended (15 observations per IV) as to include interaction terms. Furthermore, models can become rather complex when interactions are included.

6.4 Research Directions

Reiterating what we alluded to in the last section, future research on lottery sales-response-to-advertising requires a larger data sample than the one used in the present investigation. The period covered (4 years) is very short. New investigation on the sales-advertising relationship subject should also include variables related to the age of the lottery game, game innovations, and more specific demographic and socioeconomic characteristics of the market since such data could enable researchers to better model lottery games' sales-advertising behavior and, thus, obtain more accurate predictive models.

6.5 Contributions

The main contribution of this dissertation is that it addresses the managerial need for a predictive model which could be used as a tool in their operational inefficiency reduction endeavors. Also, in the modeling process, this study addresses three fundamental questions that have been at the core of advertising theory and praxis for many decades now. Additionally, the present investigation provides an encompassing analysis of the sales-advertising relationships of lottery games; there is no similar lottery study in the sales-advertising relationship literature of which we are aware. This investigation screened 192 models to address the crucial issues occupying this research endeavor. We should note that most lottery studies, for simplification purposes, assume a linear behavior in the sales-advertising relationship. Although sometimes such assumption could be justified, often that supposition can lead the researcher to inaccurate conclusions. The present investigation has tackled, we hope, effectively with this deficiency.

The findings from this research may offer some new insights about lottery games sales-advertising behavior to both academics and practitioners. Such results can be of help to lottery managers to better understand some of the mechanisms underlying their games. Practitioners can use this new knowledge to defend their decisions on advertising strategy and expenditures and, in the process, debunk mistaken beliefs frequently stigmatizing advertising as a resource-spending function.

Appendix

Apendix Tables Index

Table A1: Lotto: Current Effects, Game-Specific Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	163882.876	8.77	.000	1.703	130347328	.92
	Population	-.028	-8.04	.000			
	Unemploym.	-865.662	-1.002	.323			
	Advertising	-.001	-.638	.527			
	Jackpot	2.677	15.445	.000			
Logistic	Intercept	6.301	6.594	.000	1.697	130812329	.92
	Population	-1.45E-006	-8.009	.000			
	Unemploym.	-.042	-.942	.352			
	Advertising	-7.53E-008	-.659	.514			
	Jackpot	.000	15.501	.000			
LB Logistic	Intercept	-11.434	-5.416	.000	1.565	171277479	.88
	Population	2.85E-006	7.127	.000			
	Unemploym.	.035	.358	.723			
	Advertising	7.37E-008	.292	.772			
	Jackpot	-.00023	-11.650	.000			
Modified Exponential	Intercept	-3.522	-7.800	.000	1.794	131656767	.93
	Population	6.49E-007	7.592	.000			
	Unemploym.	.024	1.159	.253			
	Advertising	5.45E-008	1.011	.318			
	Jackpot	-7.11E-005	-16.980	.000			
Power	Ln Intercept	62.789	8.144	.000	1.742	157041613	.90
	Ln Populat	-3.535	-7.174	.000			
	Ln Unempl.	-.101	-.721	.475			
	Ln Adv.	.000	.062	.951			
	Ln Jackpot	.266	12.807	.000			
Gompertz	Intercept	-4.699	-7.113	.000	1.740	128351301	.93
	Population	9.96E-007	7.957	.000			
	Unemploym.	.032	1.058	.297			
	Advertising	6.49E-008	.822	.416			
	Jackpot	.000	-16.393	.000			
Logarithmic	Intercept	1915845.927	6.246	.000	1.855	179261831	.89
	Ln Populat	-127309.832	-6.494	.000			
	Ln Unempl.	-5199.597	-.934	.356			
	Ln Adv.	-21.338	-.273	.786			
	Ln Jackpot	10407.503	12.613	.000			
Square-Root	Intercept	284689.474	7.216	.000	1.799	140982787	.92
	Sqrt Populat	-119.486	-7.451	.000			
	Sqrt Unempl	-4551.985	-1.062	.295			
	Sqrt Adv.	-.292	-.199	.843			

	Sqrt Jackpot	345.226	14.701	.000			
Note: Fobs > Fcrit for all models (α =.001); N= 45				(*) Significant DW Test (α =.05)			

Table A2: Lotto: Current Effects, Game-Aggregate Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	166067.650	8.967	.000	1.728	131307600	.92
	Population	-.029	-8.101	.000			
	Unemploym.	-977.634	-1.159	.253			
	Advertising	-.001	-.334	.740			
	Jackpot	2.661	15.518	.000			
Logistic	Intercept	6.417	6.772	.000	1.721	131848977	.92
	Population	-1.47E-006	-8.078	.000			
	Unemploym.	-.047	-1.100	.278			
	Advertising	-3.47E-008	-.358	.722			
	Jackpot	.000	15.571	.000			
LB Logistic	Intercept	-11.524	-5.521	.000	1.600	172208602	.88
	Population	2.86E-006	7.143	.000			
	Unemploym.	.046	.480	.634			
	Advertising	-2.15E-008	-.101	.920			
	Jackpot	.000	-11.733	.000			
Modified Exponential	Intercept	-3.612	-8.065	.000	1.797	133484560	.93
	Population	6.64E-007	7.737	.000			
	Unemploym.	.027	1.336	.189			
	Advertising	3.84E-008	.838	.407			
	Jackpot	-7.07E-005	-17.050	.000			
Power	Ln Intercept	63.065	8.193	.000	1.722	156364648	.90
	Ln Populat	-3.552	-7.225	.000			
	Ln Unempl.	-.095	-.678	.502			
	Ln Adv.	-.003	-.262	.795			
	Ln Jackpot	.266	13.211	.000			
Gompertz	Intercept	-4.803	-7.328	.000	1.755	129626003	.93
	Population	1.01E-006	8.056	.000			
	Unemploym.	.037	1.226	.227			
	Advertising	3.83E-008	.572	.571			
	Jackpot	-9.99E-005	-16.457	.000			
Logarithmic	Intercept	1950380.470	6.368	.000	1.843	179063405	.89
	Ln Populat	-129435.208	-6.616	.000			
	Ln Unempl.	-5174.358	-.932	.357			
	Ln Adv.	-158.244	-.345	.732			
	Ln Jackpot	10376.053	12.931	.000			
Square-Root	Intercept	287716.942	7.457	.000	1.773	140431028	.92
	Sqrt Populat	-120.841	-7.588	.000			
	Sqrt Unempl	-4483.253	-1.081	.286			
	Sqrt Advert	-.859	-.444	.660			

	Sqrt Jackpot	345.518	14.940	.000			
Note: Fobs > Fcrit for all models (α =.001); N = 45				(*) Significant DW Test (α =.05)			

Table A3: Powerball: Current Effects, Game-Specific Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	336068.126	3.243	.002	2.347	4036150722	.81
	Population	-.045	-2.346	.024			
	Unemploym.	-17929.410	-3.357	.002			
	Advertising	.012	.728	.471			
	Jackpot	.818	12.925	.000			
Logistic	Intercept	6.114	2.537	.015	2.356	3830673899	.81
	Population	-1.14E-006	-2.532	.015			
	Unemploym.	-.437	-3.515	.001			
	Advertising	2.53E-007	.662	.512			
	Jackpot	1.93E-005	13.139	.000			
LB Logistic	Intercept	-6.176	-2.545	.015	2.362	3799313591	.82
	Population	1.15E-006	2.553	.015			
	Unemploym.	.442	3.536	.001			
	Advertising	-2.65E-007	-.690	.494			
	Jackpot	-1.96E-005	-13.254	.000			
Modified Exponential	Intercept	-3.929	-2.522	.016	2.115	6439401822	.670
	Population	5.61E-007	1.933	.060			
	Unemploym.	.229	2.857	.007			
	Advertising	5.36E-008	.217	.829			
	Jackpot	-8.81E-006	-9.268	.000			
Power	Ln Intercept	46.299	2.705	.010	2.254	5135958306	.81
	Ln Populat	-2.509	-2.271	.029			
	Ln Unempl.	-1.360	-3.032	.004			
	Ln Adv.	.008	1.089	.282			
	Ln Jackpot	.520	13.526	.000			
Gompertz	Intercept	-4.828	-2.499	.017	2.236	4537542752	.76
	Population	8.03E-007	2.233	.031			
	Unemploym.	.318	3.197	.003			
	Advertising	-6.49E-008	-.212	.833			
	Jackpot	-1.33E-005	-11.242	.000			
Logarithmic	Intercept	2601746.842	1.474	.148	2.225	6620642289	.69
	Ln Populat	-179709.032	-1.577	.123			
	Ln Unempl.	-110077.700	-2.381	.022			
	Ln Adv.	410.782	.513	.611			
	Ln Jackpot	38413.527	9.699	.000			
Square-Root	Intercept	630197.918	2.675	.011	2.230	5040190415	.76
	Sqrt Populat	-194.328	-2.095	.043			
	Sqrt Unempl	-95115.848	-2.969	.005			
	Sqrt Advert	4.143	.342	.734			
	Sqrt Jackpot	371.887	11.357	.000			
Note: Fobs > Fcrit for all models (α =.001); N = 45				(*) Significant DW Test (α =.05)			

Table A4: Powerball: Current Effects, Game-Aggregate Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	318880.513	2.783	.008	2.381	4048031258	.81
	Population	-.042	-2.029	.049			
	Unemploym.	-17749.656	-3.147	.003			
	Advertising	.010	.641	.525			
	Jackpot	.812	12.091	.000			
Logistic	Intercept	5.634	2.118	.040	2.396	3845431041	.81
	Population	-1.05E-006	-2.187	.035			
	Unemploym.	-.426	-3.257	.002			
	Advertising	2.47E-007	.676	.503			
	Jackpot	1.92E-005	12.283	.000			
LB Logistic	Intercept	-5.689	-2.124	.040	2.402	3814395705	.816
	Population	1.06E-006	2.203	.033			
	Unemploym.	.432	3.280	.002			
	Advertising	-2.54E-007	-.692	.493			
	Jackpot	-1.95E-005	-12.389	.000			
Modified Exponential	Intercept	-3.659	-2.128	.040	2.148	6345377245	.67
	Population	5.27E-007	1.701	.097			
	Unemploym.	.211	2.495	.017			
	Advertising	-5.51E-008	-.234	.816			
	Jackpot	-8.66E-006	-8.593	.000			
Power	Ln Intercept	50.667	2.706	.010	2.181	5159352047	.81
	Ln Populat	-2.743	-2.295	.027			
	Ln Unempl.	-1.748	-3.969	.000			
	Ln Adv.	-.011	-.289	.774			
	Ln Jackpot	.530	12.630	.000			
Gompertz	Intercept	-4.471	-2.099	.042	2.278	4529641886	.76
	Population	7.48E-007	1.949	.058			
	Unemploym.	.303	2.891	.006			
	Advertising	-1.31E-007	-.449	.656			
	Jackpot	-1.31E-005	-10.493	.000			
Logarithmic	Intercept	2845056.704	1.490	.144	2.206	6658754730	.69
	Ln Populat	-192859.884	-1.582	.122			
	Ln Unempl.	-130025.318	-2.895	.006			
	Ln Adv.	-715.588	-.180	.858			
	Ln Jackpot	38992.348	9.108	.000			
Square-Root	Intercept	629857.931	2.394	.021	2.245	5051200372	.761
	Sqrt Populat	-190.677	-1.900	.065			
	Sqrt Unempl	-98341.284	-3.067	.004			
	Sqrt Advert	2.962	.171	.865			
	Sqrt Jackpot	372.130	10.548	.000			
Note: Fobs > Fcrit for all models (α =.001); N = 45				(*) Significant DW Test (α =.05)			

Table A5: Scratch: Current Effects, Game-Specific Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	-54573.247	-.413	.682	1.629	7818730120	.37
	Population	.077	2.982	.005			
	Unemploym.	-14750.127	-2.319	.025			
	Advertising	.019	1.656	.105			
Logistic	Intercept	-8.753	-1.938	.060	1.715	8199642993	.346
	Population	2.80E-006	3.182	.003			
	Unemploym.	-.456	-2.095	.042			
	Advertising	4.75E-007	1.182	.244			
LB Logistic	Intercept	14.430	1.829	.075	1.644	7799253335	.36
	Population	-4.21E-006	-2.743	.009			
	Unemploym.	.960	2.527	.015			
	Advertising	-1.03E-006	-1.463	.151			
Modified Exponential	Intercept	7.370	1.854	.071	1.734	8405476255	.34
	Population	-2.46E-006	-3.177	.003			
	Unemploym.	.387	2.022	.050			
	Advertising	-3.86E-007	-1.091	.282			
Power	Ln Intercept	-13.245	-1.623	.112	1.848	7760590207	.37
	Ln Populat	1.705	3.238	.002			
	Ln Unempl.	-.397	-2.411	.020			
	Ln Adv.	.006	1.765	.085			
Gompertz	Intercept	8.046	1.899	.065	1.724	8294787509	.34
	Population	-2.62E-006	-3.181	.003			
	Unemploym.	.420	2.060	.046			
	Advertising	-4.29E-007	-1.138	.262			
Logarithmic	Intercept	-5549457.863	-3.103	.003	1.860	7780271649	.38
	Ln Populat	384682.618	3.334	.002			
	Ln Unempl.	-85393.101	-2.370	.023			
	Ln Adv.	1291.978	1.788	.081			
Square-Root	Intercept	-342764.429	-1.332	.190	1.689	7540185367	.40
	Sqrt Populat	330.376	3.081	.004			
	Sqrt Unempl	-65375.138	-2.170	.036			
	Sqrt Advert	20.131	2.116	.040			

Note: Fobs > Fcrit for all models (α =.001); N = 45	(*) Significant DW Test (α =.05)	

Table A6: Scratch: Current Effects, Game-Aggregate Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	-85632.711	-.648	.521	1.639	8007168179	.36
	Population	.083	3.287	.002			
	Unemploym.	-14866.445	-2.300	.027			
	Advertising	.014	1.309	.198			
Logistic	Intercept	-9.520	-2.109	.041	1.734	8452919642	.33
	Population	2.98E-006	3.437	.001			
	Unemploym.	-.467	-2.115	.041			
	Advertising	2.58E-007	.725	.473			
LB Logistic	Intercept	16.069	2.040	.048	1.643	7992202889	.34
	Population	-4.57E-006	-3.021	.004			
	Unemploym.	.966	2.509	.016			
	Advertising	-7.21E-007	-1.163	.252			
Modified Exponential	Intercept	7.995	2.014	.051	1.756	8677848379	.32
	Population	-2.61E-006	-3.424	.001			
	Unemploym.	.398	2.050	.047			
	Advertising	-1.94E-007	-.620	.539			
Power	Ln Intercept	-14.516	-1.840	.073	1.692	7377913848	.41
	Ln Populat	1.761	3.465	.001			
	Ln Unempl.	-.342	-2.112	.041			
	Ln Adv.	.030	2.471	.018			
Gompertz	Intercept	8.739	2.065	.045	1.745	8557232557	.33
	Population	-2.79E-006	-3.433	.001			
	Unemploym.	.431	2.084	.043			
	Advertising	-2.25E-007	-.674	.504			
Logarithmic	Intercept	-5828521.959	-3.359	.002	1.699	7346174368	.41
	Ln Populat	397230.010	3.552	.001			
	Ln Unempl.	-74029.258	-2.076	.044			
	Ln Adv.	6495.480	2.410	.021			
Square-Root	Intercept	-405906.427	-1.564	.125	1.645	7725000028	.38
	Sqrt Populat	360.434	3.372	.002			
	Sqrt Unempl	-67373.734	-2.213	.032			
	Sqrt Advert	21.308	1.841	.073			

Note: Fobs > Fcrit for all models (α =.001); N = 45			(*) Significant DW Test (α =.05)				

Table A7: Scratch: Koyck's Model, Game-Specific Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	-29747.597	-.226	.822	1.956	7437387519	.39
	Population	.056	1.926	.061			
	Unemploym.	-10954.976	-1.607	.116			
	Advertising.	.022	1.905	.064			
	Lag Sales	.217	1.432	.160			
Logistic	Intercept	-7.101	-1.486	.145	1.975	7709999283	.35
	Population	2.26E-006	2.229	.031			
	Unemploym.	-.363	-1.549	.129			
	Advertising	5.32E-007	1.314	.196			
	Lag Sales	.164	1.048	.301			
LB Logistic	Intercept	10.861	1.318	.195	1.965	7403325921	.37
	Population	-3.16E-006	-1.854	.071			
	Unemploym.	.730	1.772	.084			
	Advertising	-1.16E-006	-1.647	.107			
	Lag Sales	.208	1.362	.181			
Modified Exponential	Intercept	6.092	1.453	.154	1.978	7893713800	.34
	Population	-2.03E-006	-2.269	.029			
	Unemploym.	.314	1.522	.136			
	Advertising	-4.30E-007	-1.203	.236			
	Lag Sales	.152	.965	.340			
Power	Ln Intercept	-11.464	-1.356	.183	2.071	7635498662	.37
	Ln Populat	1.479	2.500	.017			
	Ln Unempl.	-.344	-1.948	.058			
	Ln Adv.	.005	1.581	.122			
	Lag Sales	.130	.850	.401			
Gompertz	Intercept	6.587	1.472	.149	1.976	7794100807	.34
	Population	-2.14E-006	-2.250	.030			
	Unemploym.	.338	1.536	.132			
	Advertising	-4.79E-007	-1.260	.215			
	Lag Sales	.159	1.007	.320			
Logarithmic	Intercept	-4836461.018	-2.425	.020			
	Ln Populat	335225.696	2.568	.014	2.077	7651026508	.37
	Ln Unempl.	-74197.054	-1.919	.062			
	Ln Adv.	1185.820	1.610	.115			
	Lag Sales	.126	.822	.416			
Square-Root	Intercept	-262163.152	-1.000	.323	2.001	7222033163	.41
	Sqrt Populat	254.876	2.115	.041			
	Sqrt Unempl	-49342.246	-1.533	.133			
	Sqrt Advert	21.203	2.241	.031			

	Lag Sales	.196	1.327	.192			
Note: Fobs > Fcrit for all models (α =.001); N = 45			(*) Significant DW Test (α =.05)				

Table A8: Scratch: Koyck's Model, Game-Aggregate Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	-67385.366	-.511	.612	1.940	7686815793	.37
	Population	.066	2.291	.027			
	Unemploym.	-11427.972	-1.646	.108			
	Advertising	.016	1.488	.145			
	Lag Sales	.198	1.291	.204			
Logistic	Intercept	-8.068	-1.694	.098	1.980	8003703999	.33
	Population	2.50E-006	2.501	.017			
	Unemploym.	-.381	-1.597	.118			
	Advertising	3.01E-007	.838	.407			
	Lag Sales	.153	.964	.341			
LB Logistic	Intercept	12.899	1.572	.124	1.944	7657027506	.35
	Population	-3.62E-006	-2.161	.037			
	Unemploym.	.750	1.794	.080			
	Advertising	-8.06E-007	-1.301	.201			
	Lag Sales	.196	1.272	.211			
Modified Exponential	Intercept	6.868	1.645	.108	1.986	8205885116	.32
	Population	-2.22E-006	-2.526	.016			
	Unemploym.	.329	1.572	.124			
	Advertising	-2.27E-007	-.720	.476			
	Lag Sales	.142	.890	.379			
Power	Ln Intercept	-11.918	-1.472	.149	1.988	7115571605	.42
	Ln Populat	1.436	2.536	.015			
	Ln Unempl.	-.263	-1.519	.137			
	Ln Adv.	.031	2.521	.016			
	Lag Sales	.183	1.265	.213			
Gompertz	Intercept	7.455	1.672	.102	1.983	8096441583	.33
	Population	-2.36E-006	-2.514	.016			
	Unemploym.	.354	1.585	.121			
	Advertising	-2.63E-007	-.781	.440			
	Lag Sales	.148	.928	.359			
Logarithmic	Intercept	-4793870.037	-2.500	.017	1.991	7076828756	.42
	Ln Populat	325227.544	2.591	.013			
	Ln Unempl.	-56908.414	-1.495	.143			
	Ln Adv.	6587.137	2.459	.018			
	Lag Sales	.180	1.234	.224			
Square-Root	Intercept	-328881.635	-1.246	.220	1.948	7407595177	.39
	Sqrt Populat	286.391	2.384	.022			
	Sqrt Unempl	-51294.986	-1.574	.123			
	Sqrt Advert	22.750	1.974	.055			

	Lag Sales	.196	1.309	.198			
Note: Fobs > Fcrit for all models (α =.001); N = 45			(*) Significant DW Test (α =.05)				

Table A9: Powerball: Koyck's Model, Game-Specific Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	337004.916	3.227	.003	2.275	3995679655	.81
	Population	-.044	-2.266	.029			
	Unemploym.	-18422.288	-3.387	.002			
	Advertising	.010	.587	.560			
	Jackpot	.819	12.838	.000			
	Lag Sales	-.043	-.629	.533			
Logistic	Intercept	6.069	2.494	.017	2.298	3816756554	.81
	Population	-1.12E-006	-2.463	.018			
	Unemploym.	-.447	-3.523	.001			
	Advertising	2.11E-007	.538	.594			
	Jackpot	1.94E-005	13.030	.000			
	Lag Sales	-.035	-.524	.603			
LB Logistic	Intercept	-6.134	-2.503	.017	2.308	3786148291	.81
	Population	1.14E-006	2.485	.017			
	Unemploym.	.452	3.538	.001			
	Advertising	-2.25E-007	-.569	.573			
	Jackpot	-1.97E-005	-13.138	.000			
	Lag Sales	-.034	-.501	.619			
Modified Exponential	Intercept	-3.916	-2.508	.016	1.959	6371369130	.67
	Population	5.39E-007	1.848	.072			
	Unemploym.	.238	2.934	.006			
	Advertising	8.87E-008	.354	.725			
	Jackpot	-8.82E-006	-9.254	.000			
	Lag Sales	-.080	-.908	.369			
Power	Ln Intercept	45.844	2.692	.010	2.152	4772153318	.82
	Ln Populat	-2.423	-2.200	.034			
	Ln Unempl.	-1.385	-3.101	.004			
	Ln Adv.	.009	1.170	.249			
	Ln Jackpot	.523	13.647	.000			
	Lag Sales	-.078	-1.195	.239			
Gompertz	Intercept	-4.786	-2.464	.018	2.128	4518236454	.75
	Population	7.81E-007	2.153	.038			
	Unemploym.	.329	3.259	.002			
	Advertising	-2.03E-008	-.065	.948			
	Jackpot	-1.33E-005	-11.203	.000			
	Lag Sales	-.060	-.790	.435			
	Intercept	2399713.170	1.375	.177	2.030	6270603649	.70
	Ln Populat	-165924.902	-1.472	.149			
	Ln Unempl.	-112788.594	-2.473	.018			

Logarithmic	Ln Adv.	470.037	.594	.556			
	Ln Jackpot	38672.475	9.897	.000			
	Lag Sales	-.124	-1.475	.148			
Square-Root	Intercept	632568.310	2.695	.010	2.091	4876514634	.76
	Sqrt Populat	-186.177	-2.009	.052			
	Sqrt Unempl	-100984.336	-3.125	.003			
	Sqrt Adver	1.869	.153	.879			
	Sqrt Jackpot	373.903	11.446	.000			
	Lag Sales	-.086	-1.144	.260			
Note: Fobs > Fcrit for all models (α =.001); N = 45			(*) Significant DW Test (α =.05)				

Table A10: Powerball: Koyck's Model, Game-Aggregate Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	313775.339	2.721	.010	2.307	3983358990	.81
	Population	-.040	-1.910	.063			
	Unemploym.	-17856.468	-3.150	.003			
	Advertising	.011	.683	.499			
	Jackpot	.809	11.979	.000			
	Lag Sales	-.053	-.796	.431			
Logistic	Intercept	5.457	2.028	.049	2.334	3814525894	.81
	Population	-1.01E-006	-2.088	.043			
	Unemploym.	-.429	-3.255	.002			
	Advertising	2.59E-007	.705	.485			
	Jackpot	1.91E-005	12.163	.000			
	Lag Sales	-.045	-.681	.500			
LB Logistic	Intercept	-5.518	-2.036	.049	2.342	3784995242	.81
	Population	1.03E-006	2.106	.042			
	Unemploym.	.435	3.277	.002			
	Advertising	-2.66E-007	-.718	.477			
	Jackpot	-1.94E-005	-12.266	.000			
	Lag Sales	-.044	-.664	.511			
Modified Exponential	Intercept	-3.504	-2.023	.050	2.015	6193568037	.66
	Population	4.89E-007	1.558	.127			
	Unemploym.	.209	2.465	.018			
	Advertising	-8.16E-008	-.343	.734			
	Jackpot	-8.59E-006	-8.468	.000			
	Lag Sales	-.079	-.899	.374			
Power	Ln Intercept	50.792	2.721	.010	2.074	4802950336	.81
	Ln Populat	-2.692	-2.258	.030			
	Ln Unempl.	-1.807	-4.088	.000			
	Ln Adv.	-.013	-.345	.732			
	Ln Jackpot	.534	12.719	.000			
	Lag Sales	-.074	-1.120	.270			
Gompertz	Intercept	-4.282	-1.994	.053	2.179	4476515729	.76
	Population	7.08E-007	1.824	.076			
	Unemploym.	.303	2.886	.006			
	Advertising	-1.52E-007	-.518	.607			
	Jackpot	-1.30E-005	-10.387	.000			
	Lag Sales	-.065	-.858	.396			
	Intercept	2644090.867	1.399	.170	2.024	6323414124	.69
	Ln Populat	-179033.784	-1.483	.146			
	Ln Unempl.	-134120.404	-3.020	.004			

Logarithmic	Ln Adv.	-615.525	-.156	.876			
	Ln Jackpot	39242.133	9.281	.000			
	Lag Sales	-.121	-1.438	.158			
Square-Root	Intercept	612524.707	2.337	.025	2.118	4873145338	.76
	Sqrt Populat	-178.521	-1.779	.083			
	Sqrt Unempl	-99739.188	-3.125	.003			
	Sqrt Adver	3.866	.224	.824			
	Sqrt Jackpot	371.749	10.593	.000			
	Lag Sales	-.088	-1.194	.240			
Note: Fobs > Fcrit for all models (α =.001); N = 45			(*) Significant DW Test (α =.05)				

Table A11: Lotto: Koyck's Model, Game-Specific Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	143989.734	5.533	.000	1.927	126460380	.92
	Population	-.025	-5.261	.000			
	Unemploym.	-576.371	-.639	.526			
	Advertising	-.001	-.570	.572			
	Jackpot	2.644	15.080	.000			
	Lag Sales	.061	1.095	.280			
Logistic	Intercept	5.377	4.280	.000	1.926	126596370	.92
	Population	-1.27E-006	-5.219	.000			
	Unemploym.	-.026	-.558	.580			
	Advertising	-6.80E-008	-.597	.554			
	Jackpot	.000	15.195	.000			
	Lag Sales	.062	1.129	.266			
LB Logistic	Intercept	-9.044	-3.366	.002	1.906	167005014	.88
	Population	2.34E-006	4.382	.000			
	Unemploym.	.006	.057	.955			
	Advertising	4.68E-008	.187	.852			
	Jackpot	.000	-11.360	.000			
	Lag Sales	.101	1.410	.166			
Modified Exponential	Intercept	-3.149	-5.109	.000	1.940	127136726	.92
	Population	5.83E-007	5.142	.000			
	Unemploym.	.017	.761	.451			
	Advertising	5.27E-008	.973	.336			
	Jackpot	-7.07E-005	-16.710	.000			
	Lag Sales	.043	.892	.378			
Power	Ln Intercept	50.931	4.790	.000	2.049	152345415	.90
	Ln Populat	-2.838	-4.345	.000			
	Ln Unempl.	-.040	-.284	.778			
	Ln Adv.	3.37E-005	.017	.986			
	Ln Jackpot	.261	12.683	.000			
	Lag Sales	.104	1.588	.120			
Gompertz	Intercept	-4.095	-4.643	.000	1.932	123975582	.92
	Population	8.81E-007	5.274	.000			
	Unemploym.	.021	.660	.513			
	Advertising	6.09E-008	.771	.445			
	Jackpot	-9.96E-005	-16.103	.000			
	Lag Sales	.053	1.032	.308			
	Intercept	1545991.350	3.776	.001	2.071	171292663	.89
	Ln Populat	-103650.689	-3.960	.000			
	Ln Unempl.	-2568.411	-.439	.663			

Logarithmic	Ln Adv.	-28.262	-.364	.718			
	Ln Jackpot	10278.375	12.497	.000			
	Lag Sales	.088	1.347	.186			
Square-Root	Intercept	242045.625	4.571	.000	2.015	135967895	.91
	Sqrt Populat	-102.535	-4.812	.000			
	Sqrt Unempl	-2948.336	-.660	.513			
	Sqrt Adver	-.201	-.137	.891			
	Sqrt Jackpot	340.721	14.404	.000			
	Lag Sales	.070	1.199	.238			
Note: Fobs > Fcrit for all models (α =.001); N = 45			(*) Significant DW Test (α =.05)				

Table A12: Lotto: Koyck's Model, Game-Aggregate Advertising, Full Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	145544.821	5.576	.000	1.952	127270186	.92
	Population	-.025	-5.263	.000			
	Unemploym.	-674.904	-.764	.450			
	Advertising	-.001	-.274	.786			
	Jackpot	2.629	15.171	.000			
	Lag Sales	.062	1.112	.273			
Logistic	Intercept	5.466	4.342	.000	1.949	127533464	.92
	Population	-1.28E-006	-5.227	.000			
	Unemploym.	-.031	-.684	.498			
	Advertising	-2.89E-008	-.299	.767			
	Jackpot	.000	15.279	.000			
	Lag Sales	.063	1.143	.260			
LB Logistic	Intercept	-9.051	-3.370	.002	1.937	168123156	.88
	Population	2.33E-006	4.345	.000			
	Unemploym.	.014	.145	.885			
	Advertising	-3.77E-008	-.179	.859			
	Jackpot	.000	-11.472	.000			
	Lag Sales	.103	1.436	.159			
Modified Exponential	Intercept	-3.235	-5.239	.000	1.942	129015256	.92
	Population	5.97E-007	5.226	.000			
	Unemploym.	.020	.912	.367			
	Advertising	3.64E-008	.791	.434			
	Jackpot	-7.02E-005	-16.779	.000			
	Lag Sales	.043	.887	.380			
Power	Ln Intercept	50.975	4.718	.000	2.047	152245136	.90
	Ln Populat	-2.841	-4.286	.000			
	Ln Unempl.	-.040	-.281	.780			
	Ln Adv.	.000	-.029	.977			
	Ln Jackpot	.261	12.990	.000			
	Lag Sales	.104	1.566	.125			
Gompertz	Intercept	-4.185	-4.733	.000	1.947	125188264	.92
	Population	8.95E-007	5.311	.000			
	Unemploym.	.025	.798	.430			
	Advertising	3.48E-008	.518	.607			
	Jackpot	-9.90E-005	-16.174	.000			
	Lag Sales	.053	1.039	.305			
	Intercept	1588943.893	3.844	.000	2.061	171741857	.89
	Ln Populat	-106335.258	-4.026	.000			
	Ln Unempl.	-2837.685	-.490	.627			

Logarithmic	Ln Adv.	-80.005	-.174	.863			
	Ln Jackpot	10222.349	12.703	.000			
	Lag Sales	.085	1.289	.205			
Square-Root	Intercept	245067.881	4.637	.000	1.995	135634909	.91
	Sqrt Populat	-103.863	-4.841	.000			
	Sqrt Unempl	-2909.587	-.671	.506			
	Sqrt Adver	-.655	-.339	.737			
	Sqrt Jackpot	341.095	14.624	.000			
	Lag Sales	.068	1.174	.247			
Note: Fobs > Fcrit for all models (α =.001); N = 45			(*) Significant DW Test (α =.05)				

Table A13: Lotto: Current Effects, Game-Specific Advertising, No-Outliers Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	164738.09	8.656	.000	1.572	111574933	.88
	Population	-.028	-7.889	.000			
	Unemploym.	-1216.85	-1.334	.191			
	Advertising	.002	.693	.493			
	Jackpot	2.746	11.502	.000			
Logistic	Intercept	6.351	6.494	.000	1.569	113116324	.88
	Population	-1.44E-006	-7.834	.000			
	Unemploym.	-.059	-1.265	.214			
	Advertising	1.23E-007	.673	.505			
	Jackpot	.000	11.386	.000			
LB Logistic	Intercept	-11.728	-5.487	.000	1.549	134259748	.85
	Population	2.89E-006	7.188	.000			
	Unemploym.	.073	.711	.482			
	Advertising	-2.32E-007	-.578	.567			
	Jackpot	.000	-9.897	.000			
Modified Exponential	Intercept	-3.506	-8.112	.000	1.580	107978976	.88
	Population	6.35E-007	7.797	.000			
	Unemploym.	.031	1.496	.144			
	Advertising	-4.98E-008	-.615	.543			
	Jackpot	-6.43E-005	-11.869	.000			
Power	Ln Intercept	61.606	7.883	.000	1.505	128601306	.86
	Ln Populat	-3.453	-6.902	.000			
	Ln Unempl.	-.082	-.557	.581			
	Ln Adv.	.002	.728	.472			
	Ln Jackpot	.249	9.943	.000			
Gompertz	Intercept	-4.709	-7.081	.000	1.574	110384848	.88
	Population	9.84E-007	7.853	.000			
	Unemploym.	.044	1.372	.179			
	Advertising	-8.15E-008	-.653	.518			
	Jackpot	-9.71E-005	-11.640	.000			
Logarithmic	Intercept	1830051.13	6.560	.000	1.518	127160978	.86
	Ln Populat	-121135.69	-6.783	.000			
	Ln Unempl.	-4158.262	-.793	.433			
	Ln Adv.	57.550	.740	.464			
	Ln Jackpot	8958.385	10.021	.000			
Square-Root	Intercept	282574.325	7.260	.000	1.562	115363277	.87
	Sqrt Populat	-117.552	-7.436	.000			
	Sqrt Unempl	-5021.609	-1.157	.255			
	Sqrt Adv.	1.582	.881	.384			

	Sqrt Jackpot	321.322	11.168	.000			
Note: Fobs > Fcrit for all models (α =.001); N= 40				(*) Significant DW Test (α =.05)			

Table A14: Lotto: Current Effects, Game-Aggregate Advertising, No-Outliers Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	159663.430	8.610	.000	1.653	109229927	.879
	Population	-.027	-7.697	.000			
	Unemploym.	-1153.789	-1.342	.188			
	Advertising	.003	1.114	.273			
	Jackpot	2.745	11.639	.000			
Logistic	Intercept	6.096	6.396	.000	1.649	110789624	.877
	Population	-1.40E-006	-7.645	.000			
	Unemploym.	-.056	-1.273	.211			
	Advertising	1.49E-007	1.096	.280			
	Jackpot	.000	11.519	.000			
LB Logistic	Intercept	-11.236	-5.388	.000	1.619	132694062	0.850
	Population	2.80E-006	7.014	.000			
	Unemploym.	.068	.704	.486			
	Advertising	-2.98E-007	-1.000	.324			
	Jackpot	.000	-10.000	.000			
Modified Exponential	Intercept	-3.402	-8.069	.000	1.656	105468024	.882
	Population	6.15E-007	7.620	.000			
	Unemploym.	.030	1.527	.136			
	Advertising	-6.21E-008	-1.029	.310			
	Jackpot	-6.43E-005	-11.995	.000			
Power	Ln Intercept	59.953	7.460	.000	1.547	130748718	.859
	Ln Populat	-3.352	-6.531	.000			
	Ln Unempl.	-.073	-.498	.622			
	Ln Adv.	.006	.459	.649			
	Ln Jackpot	.254	10.483	.000			
Gompertz	Intercept	-4.540	-7.003	.000	1.653	107936348	.88
	Population	9.52E-007	7.669	.000			
	Unemploym.	.042	1.390	.173			
	Advertising	-9.96E-008	-1.074	.290			
	Jackpot	-9.71E-005	-11.773	.000			
Logarithmic	Intercept	1763104.769	6.154	.000	1.569	127988308	.858
	Ln Populat	-117069.907	-6.397	.000			
	Ln Unempl.	-3882.737	-.742	.463			
	Ln Adv.	268.187	.564	.576			
	Ln Jackpot	9129.078	10.579	.000			
Square-Root	Intercept	270395.943	7.002	.000	1.619	115774508	.872
	Sqrt Populat	-112.926	-7.092	.000			
	Sqrt Unempl	-4322.406	-1.030	.310			
	Sqrt Advert	1.899	.806	.426			

	Sqrt Jackpot	322.924	11.251	.000			
Note: Fobs > Fcrit for all models (α =.001); N = 40				(*) Significant DW Test (α =.001)			

Table A15: Powerball: Current Effects, Game-Specific Advertising, No-Outliers Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	334136.208	2.936	.006	2.421	3897435723	.824
	Population	-.043	-2.006	.053			
	Unemploym.	-19268.368	-3.193	.003			
	Advertising	.004	.208	.836			
	Jackpot	.825	12.167	.000			
Logistic	Intercept	6.080	2.299	.028	2.422	3716585659	.827
	Population	-1.09E-006	-2.174	.037			
	Unemploym.	-.469	-3.343	.002			
	Advertising	5.96E-008	.120	.905			
	Jackpot	1.95E-005	12.370	.000			
LB Logistic	Intercept	-6.141	-2.307	.027	2.430	3685721197	.830
	Population	1.10E-006	2.193	.035			
	Unemploym.	.475	3.363	.002			
	Advertising	-6.81E-008	-.136	.892			
	Jackpot	-1.98E-005	-12.480	.000			
Modified Exponential	Intercept	-3.938	-2.285	.028	2.163	6303124509	.697
	Population	5.40E-007	1.658	.106			
	Unemploym.	.248	2.712	.010			
	Advertising	1.24E-007	.384	.703			
	Jackpot	-8.93E-006	-8.692	.000			
Power	Ln Intercept	43.446	2.376	.023	2.502	4842231481	.839
	Ln Populat	-2.308	-1.954	.059			
	Ln Unempl.	-1.522	-3.114	.004			
	Ln Adv.	.003	.383	.704			
	Ln Jackpot	.529	13.152	.000			
Gompertz	Intercept	-4.820	-2.262	.030	2.290	4418093910	.775
	Population	7.70E-007	1.914	.064			
	Unemploym.	.343	3.036	.004			
	Advertising	5.57E-008	.139	.890			
	Jackpot	-1.34E-005	-10.556	.000			
Logarithmic	Intercept	2500293.688	1.289	.206	2.352	6206766016	.719
	Ln Populat	-171946.896	-1.372	.179			
	Ln Unempl.	-124439.968	-2.399	.022			
	Ln Adv.	59.260	.065	.949			
	Ln Jackpot	39438.022	9.243	.000			
Square-Root	Intercept	629733.281	2.458	.019	2.328	4788138625	.783
	Sqrt Populat	-182.970	-1.785	.083			
	Sqrt Unempl	-105015.033	-2.917	.006			
	Sqrt Advert	-1.706	-.114	.910			
	Sqrt Jackpot	378.065	10.821	.000			

Note: Fobs > Fcrit for all models (α =.001); N = 40	(*) Significant DW Test (α =.05)	

Table A16: Powerball: Current Effects, Game-Aggregate Advertising, No-Outliers Set

	Powerball (Aggregate Advertising)						
Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	323261.272	2.590	.014	2.443	3894895360	.824
	Population	-.041	-1.830	.076			
	Unemploym.	-18985.373	-3.006	.005			
	Advertising	.005	.257	.798			
	Jackpot	.821	11.415	.000			
Logistic	Intercept	5.758	1.986	.055	2.452	3713988278	.828
	Population	-1.04E-006	-1.985	.055			
	Unemploym.	-.454	-3.095	.004			
	Advertising	1.21E-007	.291	.773			
	Jackpot	1.93E-005	11.579	.000			
LB Logistic	Intercept	-5.814	-1.992	.054	2.460	3683336174	.830
	Population	1.05E-006	2.000	.053			
	Unemploym.	.460	3.117	.004			
	Advertising	-1.25E-007	-.298	.767			
	Jackpot	-1.97E-005	-11.684	.000			
Modified Exponential	Intercept	-3.758	-1.983	.055	2.199	6185849236	.695
	Population	5.32E-007	1.556	.129			
	Unemploym.	.225	2.348	.025			
	Advertising	-3.43E-008	-.127	.900			
	Jackpot	-8.77E-006	-8.031	.000			
Power	Ln Intercept	48.088	2.499	.017	2.397	4808098576	.840
	Ln Populat	-2.563	-2.083	.045			
	Ln Unempl.	-1.823	-3.938	.000			
	Ln Adv.	-.025	-.633	.531			
	Ln Jackpot	.542	12.562	.000			
Gompertz	Intercept	-4.582	-1.960	.058	2.325	4395322295	.775
	Population	7.46E-007	1.771	.085			
	Unemploym.	.323	2.731	.010			
	Advertising	-6.82E-008	-.204	.840			
	Jackpot	-1.32E-005	-9.834	.000			
Logarithmic	Intercept	2755585.918	1.347	.187	2.295	6184601269	.720
	Ln Populat	-186331.351	-1.425	.163			
	Ln Unempl.	-137416.093	-2.792	.008			
	Ln Adv.	-1537.240	-.360	.721			
	Ln Jackpot	40127.233	8.752	.000			
Square-Root	Intercept	634788.346	2.241	.031	2.321	4788969309	.783
	Sqrt Populat	-186.076	-1.718	.095			
	Sqrt Unempl	-104276.277	-2.933	.006			

	Sqrt Advert	-1.583	-.083	.935			
	Sqrt Jackpot	378.475	10.033	.000			
Note: Fobs > Fcrit for all models (α =.001); N = 40				(*) Significant DW Test (α =.05)			

Table A17: Scratch: Current Effects, Game-Specific Advertising, No-Outliers Dataset

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	-14640.294	-.098	.923	1.476	7630152441	.39
	Population	.069	2.364	.024			
	Unemploym.	-15677.571	-2.224	.032			
	Advertising	.023	1.745	.090			
Logistic	Intercept	-7.834	-1.516	.138	1.619	7945929911	.36
	Population	2.62E-006	2.610	.013			
	Unemploym.	-.480	-1.976	.056			
	Advertising	5.46E-007	1.195	.240			
LB Logistic	Intercept	12.525	1.398	.171	1.549	7633053867	.39
	Population	-3.88E-006	-2.222	.033			
	Unemploym.	1.032	2.450	.019			
	Advertising	-1.25E-006	-1.578	.123			
Modified Exponential	Intercept	6.635	1.457	.154	1.650	8146654119	.351
	Population	-2.32E-006	-2.620	.013			
	Unemploym.	.407	1.902	.065			
	Advertising	-4.39E-007	-1.090	.283			
Power	Ln Intercept	-11.051	-1.189	.242	1.788	7641122762	.387
	Ln Populat	1.565	2.610	.013			
	Ln Unempl.	-.425	-2.337	.025			
	Ln Adv.	.006	1.774	.085			
Gompertz	Intercept	7.221	1.489	.145	1.634	8038460324	.356
	Population	-2.47E-006	-2.616	.013			
	Unemploym.	.442	1.940	.060			
	Advertising	-4.90E-007	-1.144	.260			
Logarithmic	Intercept	-5062725.48	-2.485	.018	1.794	7651311494	.391
	Ln Populat	353582.357	2.690	.011			
	Ln Unempl.	-91320.433	-2.290	.028			
	Ln Adv.	1388.889	1.787	.082			
Square-Root	Intercept	-263012.186	-.906	.371	1.567	7290455005	.420
	Sqrt Populat	297.922	2.459	.019			
	Sqrt Unempl	-70217.893	-2.128	.040			

	Sqrt Advert	23.904	2.235	.032			
Note: Fobs > Fcrit for all models (α =.001); N = 40			(*) Significant DW Test (α =.05)				

Table A18: Scratch: Current Effects, Game-Aggregate Advertising, No-Outliers Set

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	-58027.235	-.386	.702	1.476	7888787488	.372
	Population	.078	2.713	.010			
	Unemploym.	-15630.314	-2.168	.037			
	Advertising	.016	1.329	.192			
Logistic	Intercept	-8.856	-1.716	.095	1.636	8316579953	.345
	Population	2.86E-006	2.888	.007			
	Unemploym.	-.487	-1.970	.057			
	Advertising	2.82E-007	.703	.487			
LB Logistic	Intercept	14.871	1.660	.106	1.535	7892024105	.371
	Population	-4.38E-006	-2.546	.015			
	Unemploym.	1.029	2.396	.022			
	Advertising	-8.45E-007	-1.215	.232			
Modified Exponential	Intercept	7.457	1.642	.109	1.670	8546534319	.336
	Population	-2.52E-006	-2.885	.007			
	Unemploym.	.415	1.905	.065			
	Advertising	-2.08E-007	-.590	.559			
Power	Ln Intercept	-13.433	-1.502	.142	1.546	7243193154	.429
	Ln Populat	1.690	2.933	.006			
	Ln Unempl.	-.357	-1.991	.054			
	Ln Adv.	.033	2.454	.019			
Gompertz	Intercept	8.140	1.682	.101	1.653	8423219752	.340
	Population	-2.68E-006	-2.888	.007			
	Unemploym.	.450	1.938	.060			
	Advertising	-2.44E-007	-.648	.521			
Logarithmic	Intercept	-5582051.15	-2.833	.008	1.553	7197735371.86	.427
	Ln Populat	381029.396	3.002	.005			
	Ln Unempl.	-76894.327	-1.948	.059			
	Ln Adv.	7066.901	2.379	.023			
Square-Root	Intercept	-360097.703	-1.224	.229	1.489	7578673598	.397
	Sqrt Populat	341.911	2.819	.008			
	Sqrt Unempl	-70493.472	-2.086	.044			
	Sqrt Advert	24.007	1.853	.072			
Note: Fobs > Fcrit for all models (α =.001); N = 40			(*) Significant DW Test (α =.05)				

Table A19: Scratch: Koyck's Model, Game-Specific Advertising, No-Outliers Set

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	22376.972	.149	.882	1.817	7187678916	.428
	Population	.042	1.226	.228			
	Unemploym.	-10325.215	-1.317	.196			
	Advertising.	.026	1.964	.058			
	Lag Sales	.262	1.468	.151			
Logistic	Intercept	-5.782	-1.044	.304	1.880	7445157435	.380
	Population	1.96E-006	1.645	.109			
	Unemploym.	-.360	-1.334	.191			
	Advertising	5.96E-007	1.298	.203			
	Lag Sales	.186	1.024	.313			
LB Logistic	Intercept	8.322	.877	.386	1.858	7170906407	.415
	Population	-2.62E-006	-1.316	.197			
	Unemploym.	.744	1.565	.127			
	Advertising	-1.34E-006	-1.700	.098			
	Lag Sales	.225	1.267	.213			
Modified Exponential	Intercept	5.064	1.042	.305	1.891	7636914831	.366
	Population	-1.80E-006	-1.711	.096			
	Unemploym.	.313	1.323	.194			
	Advertising	-4.76E-007	-1.176	.248			
	Lag Sales	.170	.935	.356			
Power	Ln Intercept	-8.459	-.861	.395	2.000	7491706958	.400
	Ln Populat	1.263	1.805	.080			
	Ln Unempl.	-.348	-1.703	.097			
	Ln Adv.	.006	1.525	.136			
	Lag Sales	.156	.846	.403			
Gompertz	Intercept	5.419	1.045	.303	1.885	7532714986	.373
	Population	-1.88E-006	-1.678	.102			
	Unemploym.	.336	1.329	.193			
	Advertising	-5.34E-007	-1.238	.224			
	Lag Sales	.178	.981	.333			
Logarithmic	Intercept	-4095100.76	-1.740	.091	2.004	7503046345	.403
	Ln Populat	286575.868	1.853	.072			
	Ln Unempl.	-74702.890	-1.669	.104			
	Ln Adv.	1237.865	1.544	.132			
	Lag Sales	.153	.832	.411			
Square-Root	Intercept	-158215.975	-.530	.600	1.890	6956548160	.446
	Sqrt Populat	202.574	1.439	.159			
	Sqrt Unempl	-48845.233	-1.334	.191			
	Sqrt Advert	24.246	2.287	.028			

	Lag Sales	.225	1.296	.203			
Note: Fobs > Fcrit for all models (α =.001); N = 40			(*) Significant DW Test (α =.05)				

Table A20: Scratch: Koyck's Model, Game-Aggregate Advertising, No-Outliers Set

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	-29525.400	-.196	.846	1.771	7529991713	.401
	Population	.055	1.633	.111			
	Unemploym.	-10875.654	-1.353	.185			
	Advertising	.017	1.445	.157			
	Lag Sales	.234	1.291	.205			
Logistic	Intercept	-7.042	-1.276	.210	1.877	7862959185	.361
	Population	2.27E-006	1.927	.062			
	Unemploym.	-.376	-1.367	.180			
	Advertising	3.12E-007	.774	.444			
	Lag Sales	.173	.938	.355			
LB Logistic	Intercept	11.127	1.174	.248	1.811	7519251488	.394
	Population	-3.25E-006	-1.652	.107			
	Unemploym.	.763	1.574	.125			
	Advertising	-8.85E-007	-1.277	.210			
	Lag Sales	.209	1.160	.254			
Modified Exponential	Intercept	6.061	1.253	.219	1.894	8078580946	.349
	Population	-2.04E-006	-1.973	.056			
	Unemploym.	.327	1.358	.183			
	Advertising	-2.32E-007	-.654	.517			
	Lag Sales	.158	.860	.396			
Power	Ln Intercept	-9.824	-1.045	.303	1.827	6968980943	.451
	Ln Populat	1.281	1.915	.064			
	Ln Unempl.	-.254	-1.281	.209			
	Ln Adv.	.032	2.416	.021			
	Lag Sales	.203	1.185	.244			
Gompertz	Intercept	6.542	1.266	.214	1.886	7961840189	.355
	Population	-2.15E-006	-1.950	.059			
	Unemploym.	.351	1.363	.182			
	Advertising	-2.71E-007	-.716	.479			
	Lag Sales	.166	.900	.374			
Logarithmic	Intercept	-4256195.28	-1.880	.068	1.833	6926161896	.449
	Ln Populat	289328.695	1.947	.060			
	Ln Unempl.	-54517.922	-1.248	.220			
	Ln Adv.	6933.720	2.345	.025			
	Lag Sales	.202	1.171	.249			
Square-Root	Intercept	-257078.134	-.849	.402	1.781	7246647117	.423
	Sqrt Populat	247.418	1.748	.089			
	Sqrt Unempl	-49134.260	-1.310	.199			
	Sqrt Advert	24.455	1.903	.065			

	Lag Sales	.224	1.266	.214			
Note: Fobs > Fcrit for all models (α =.001); N = 40			(*) Significant DW Test (α =.05)				

Table A21: Powerball: Koyck's Model, Game-Specific Advertising, No-Outliers Set

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	333835.347	2.917	.006	2.308	3828634935	.827
	Population	-.041	-1.908	.065			
	Unemploym.	-19859.174	-3.247	.003			
	Advertising	.001	.058	.954			
	Jackpot	.826	12.114	.000			
	Lag Sales	-.057	-.782	.440			
Logistic	Intercept	5.986	2.243	.032	2.326	3687521528	.830
	Population	-1.06E-006	-2.089	.044			
	Unemploym.	-.481	-3.378	.002			
	Advertising	-7.77E-009	-.015	.988			
	Jackpot	1.95E-005	12.290	.000			
	Lag Sales	-.049	-.680	.501			
LB Logistic	Intercept	-6.049	-2.250	.031	2.337	91448120	.832
	Population	1.07E-006	2.109	.042			
	Unemploym.	.487	3.394	.002			
	Advertising	-1.76E-009	-.003	.997			
	Jackpot	-1.98E-005	-12.394	.000			
	Lag Sales	-.047	-.661	.513			
Modified Exponential	Intercept	-3.908	-2.264	.030	1.969	6186294480	.704
	Population	5.13E-007	1.568	.126			
	Unemploym.	.256	2.785	.009			
	Advertising	1.70E-007	.520	.607			
	Jackpot	-8.93E-006	-8.682	.000			
	Lag Sales	-.089	-.940	.354			
Power	Ln Intercept	43.382	2.428	.021	2.356	4309158696	.851
	Ln Populat	-2.228	-1.928	.062			
	Ln Unempl.	-1.548	-3.239	.003			
	Ln Adv.	.004	.502	.619			
	Ln Jackpot	.536	13.555	.000			
	Lag Sales	-.109	-1.628	.113			
Gompertz	Intercept	-4.742	-2.217	.033	2.140	4376033664	.780
	Population	7.38E-007	1.822	.077			
	Unemploym.	.355	3.108	.004			
	Advertising	1.18E-007	.291	.773			
	Jackpot	-1.34E-005	-10.537	.000			
	Lag Sales	-.072	-.882	.384			
	Intercept	2314787.746	1.225	.229	2.084	5702882787	.742
	Ln Populat	-159307.532	-1.305	.201			
	Ln Unempl.	-127171.663	-2.519	.017			

Logarithmic	Ln Adv.	135.538	.153	.880			
	Ln Jackpot	39969.143	9.606	.000			
	Lag Sales	-.152	-1.733	.092			
Square-Root	Intercept	632030.019	2.499	.017	2.115	4530990233	.795
	Sqrt Populat	-172.030	-1.695	.099			
	Sqrt Unempl	-112611.393	-3.132	.004			
	Sqrt Adver	-5.269	-.350	.728			
	Sqrt Jackpot	381.291	11.033	.000			
	Lag Sales	-.110	-1.389	.174			
Note: Fobs > Fcrit for all models (α =.001); N = 40			(*) Significant DW Test (α =.05)				

Table A22: Powerball: Koyck's Model, Game-Aggregate Advertising, No-Outliers Set

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	316346.194	2.518	.017	2.346	3816149320	.827
	Population	-.039	-1.712	.096			
	Unemploym.	-18885.078	-2.977	.005			
	Advertising	.006	.338	.737			
	Jackpot	.817	11.286	.000			
	Lag Sales	-.060	-.838	.408			
Logistic	Intercept	5.533	1.884	.068	2.370	3681270136	.830
	Population	-9.98E-007	-1.886	.068			
	Unemploym.	-.453	-3.064	.004			
	Advertising	1.49E-007	.354	.725			
	Jackpot	1.93E-005	11.440	.000			
	Lag Sales	-.051	-.721	.476			
LB Logistic	Intercept	-5.593	-1.892	.067	2.380	3652358561	.833
	Population	1.01E-006	1.903	.066			
	Unemploym.	.459	3.087	.004			
	Advertising	-1.51E-007	-.358	.722			
	Jackpot	-1.96E-005	-11.543	.000			
	Lag Sales	-.050	-.705	.486			
Modified Exponential	Intercept	-3.580	-1.875	.069	2.043	5990847388	.702
	Population	4.92E-007	1.426	.163			
	Unemploym.	.220	2.281	.029			
	Advertising	-7.50E-008	-.272	.787			
	Jackpot	-8.67E-006	-7.880	.000			
	Lag Sales	-.086	-.903	.373			
Power	Ln Intercept	48.479	2.577	.014	2.232	4262747532	.852
	Ln Populat	-2.507	-2.083	.045			
	Ln Unempl.	-1.896	-4.169	.000			
	Ln Adv.	-.027	-.693	.493			
	Ln Jackpot	.550	12.952	.000			
	Lag Sales	-.108	-1.621	.114			
Gompertz	Intercept	-4.356	-1.846	.074	2.202	4335591007	.780
	Population	7.03E-007	1.652	.108			
	Unemploym.	.319	2.689	.011			
	Advertising	-1.05E-007	-.312	.757			
	Jackpot	-1.32E-005	-9.704	.000			
	Lag Sales	-.071	-.877	.387			
	Intercept	2540805.322	1.274	.211	2.033	5691566078	.742
	Ln Populat	-171823.207	-1.347	.187			
	Ln Unempl.	-140944.054	-2.940	.006			

Logarithmic	Ln Adv.	-1253.825	-.302	.765			
	Ln Jackpot	40583.152	9.078	.000			
	Lag Sales	-.151	-1.716	.095			
Square-Root	Intercept	611855.767	2.181	.036	2.147	4547286058	.794
	Sqrt Populat	-172.389	-1.602	.118			
	Sqrt Unempl	-104389.710	-2.970	.005			
	Sqrt Adver	.401	.021	.983			
	Sqrt Jackpot	377.942	10.133	.000			
	Lag Sales	-.105	-1.344	.188			
Note: Fobs > Fcrit for all models (α =.001); N = 40			(*) Significant DW Test (α =.05)				

Table A23: Lotto: Koyck's Model, Game-Specific Advertising, No-Outliers Set

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	131686.208	4.999	.000	1.976	102248347	.887
	Population	-.022	-4.664	.000			
	Unemploym.	-770.769	-.836	.409			
	Advertising	.003	.832	.411			
	Jackpot	2.647	11.095	.000			
	Lag Sales	.100	1.761	.087			
Logistic	Intercept	4.835	3.790	.001	1.973	103612822.91	.885
	Population	-1.14E-006	-4.611	.000			
	Unemploym.	-.035	-.734	.468			
	Advertising	1.42E-007	.796	.432			
	Jackpot	.000	11.025	.000			
	Lag Sales	.099	1.779	.084			
LB Logistic	Intercept	-8.926	-3.280	.002	1.965	127054246	.858
	Population	2.29E-006	4.207	.000			
	Unemploym.	.044	.432	.668			
	Advertising	-2.95E-007	-.749	.459			
	Jackpot	.000	-9.450	.000			
	Lag Sales	.117	1.608	.117			
Modified Exponential	Intercept	-2.685	-4.649	.000	1.984	97175250	.893
	Population	4.88E-007	4.592	.000			
	Unemploym.	.016	.732	.469			
	Advertising	-5.32E-008	-.685	.498			
	Jackpot	-6.21E-005	-11.717	.000			
	Lag Sales	.092	2.040	.049			
Power	Ln Intercept	45.523	4.239	.000	1.987	114813502	.876
	Ln Populat	-2.503	-3.791	.001			
	Ln Unempl.	-.011	-.079	.937			
	Ln Adv.	.002	.795	.432			
	Ln Jackpot	.239	9.831	.000			
	Lag Sales	.139	2.084	.045			
Gompertz	Intercept	-3.585	-4.091	.000	1.978	100288480	.889
	Population	7.69E-007	4.623	.000			
	Unemploym.	.024	.741	.464			
	Advertising	-9.09E-008	-.755	.456			
	Jackpot	-9.37E-005	-11.360	.000			
	Lag Sales	.096	1.883	.068			
	Intercept	1266137.285	3.473	.001	1.991	110753179	.878
	Ln Populat	-84958.245	-3.637	.001			
	Ln Unempl.	-509.788	-.098	.923			

Logarithmic	Ln Adv.	53.302	.724	.474			
	Ln Jackpot	8638.978	10.065	.000			
	Lag Sales	.132	2.244	.031			
Square-Root	Intercept	210137.916	4.079	.000	2.013		.886
	Sqrt Populat	-88.421	-4.246	.000			
	Sqrt Unempl	-2471.250	-.569	.573			
	Sqrt Adver	1.735	1.008	.321			
	Sqrt Jackpot	309.224	10.969	.000			
	Lag Sales	.116	2.037	.049			
Note: Fobs > Fcrit for all models (α =.001); N = 40			(*) Significant DW Test (α =.05)				

Table A24: Lotto: Koyck's Model, Game-Aggregate Advertising, No-Outliers Set

Model	Predictor	B value	t	Prob.	DW	SSR	RSQR
Linear	Intercept	124370.061	4.762	.000	2.093	99159014	.890
	Population	-.021	-4.390	.000			
	Unemploym.	-675.598	-.777	.443			
	Advertising	.003	1.331	.192			
	Jackpot	2.643	11.262	.000			
	Lag Sales	.105	1.858	.072			
Logistic	Intercept	4.475	3.547	.001	2.091	100531251	.889
	Population	-1.07E-006	-4.345	.000			
	Unemploym.	-.030	-.677	.503			
	Advertising	1.73E-007	1.308	.199			
	Jackpot	.000	11.188	.000			
	Lag Sales	.104	1.878	.069			
LB Logistic	Intercept	-8.256	-3.049	.004	2.051	125481919	.861
	Population	2.16E-006	3.964	.000			
	Unemploym.	.035	.367	.716			
	Advertising	-3.46E-007	-1.183	.245			
	Jackpot	.000	-9.572	.000			
	Lag Sales	.120	1.667	.105			
Modified Exponential	Intercept	-2.531	-4.448	.000	2.115	93414300	.896
	Population	4.59E-007	4.346	.000			
	Unemploym.	.014	.697	.491			
	Advertising	-7.28E-008	-1.265	.215			
	Jackpot	-6.20E-005	-11.889	.000			
	Lag Sales	.096	2.160	.038			
Power	Ln Intercept	41.669	3.711	.001	2.101	114972780	.877
	Ln Populat	-2.271	-3.297	.002			
	Ln Unempl.	-.001	-.009	.993			
	Ln Adv.	.012	.913	.368			
	Ln Jackpot	.243	10.396	.000			
	Lag Sales	.151	2.217	.033			
Gompertz	Intercept	-3.341	-3.861	.000	2.103	96871915	.893
	Population	7.23E-007	4.363	.000			
	Unemploym.	.021	.692	.493			
	Advertising	-1.16E-007	-1.297	.203			
	Jackpot	-9.35E-005	-11.528	.000			
	Lag Sales	.100	1.994	.054			
	Intercept	1120650.232	2.974	.005	2.123	109075463	.879
	Ln Populat	-75945.361	-3.152	.003			
	Ln Unempl.	-115.016	-.022	.982			

Logarithmic	Ln Adv.	464.825	1.027	.312			
	Ln Jackpot	8758.783	10.649	.000			
	Lag Sales	.144	2.428	.021			
Square-Root	Intercept	191717.016	3.681	.001	2.123	102092237	.887
	Sqrt Populat	-81.210	-3.824	.001			
	Sqrt Unempl	-1661.849	-.397	.694			
	Sqrt Adver	2.547	1.124	.269			
	Sqrt Jackpot	310.134	11.078	.000			
	Lag Sales	.122	2.135	.040			
Note: Fobs > Fcrit for all models (α =.001); N = 40			(*) Significant DW Test (α =.05)				

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